```
from keras.datasets import mnist
from keras.layers import Input, Dense, Reshape, Flatten, Dropout
from keras.layers import BatchNormalization, Activation, ZeroPadding2D
from keras.layers import LeakyReLU
from keras.layers import UpSampling2D, Conv2D
from keras.models import Sequential, Model
from keras.optimizers import Adam

import matplotlib.pyplot as plt
from tqdm import tqdm

import numpy as np


np.random.seed(10)

# The dimension of our random noise vector.
random_dim = 100


def load_minst_data():
    # load the data
    (x_train, y_train), (x_test, y_test) = mnist.load_data()
    # normalize our inputs to be in the range[-1, 1]
    x_train = (x_train.astype(np.float32) - 127.5)/127.5
    # convert x_train with a shape of (60000, 28, 28) to (60000, 784) so we have
    # 784 columns per row
    x_train = x_train.reshape(60000, 784)
    return (x_train, y_train, x_test, y_test)


def get_generator():
    generator = Sequential()
    generator.add(Dense(256, input_dim=random_dim))
    generator.add(LeakyReLU(0.2))

    generator.add(Dense(512))
    generator.add(LeakyReLU(0.2))

    generator.add(Dense(1024))
    generator.add(LeakyReLU(0.2))

    generator.add(Dense(784, activation='tanh'))
    generator.compile(loss='binary_crossentropy', optimizer='rmsprop')
    generator.summary()
    return generator


def get_discriminator():
    discriminator = Sequential()
    discriminator.add(Dense(1024, input_dim=784))
    discriminator.add(LeakyReLU(0.2))
    discriminator.add(Dropout(0.3))

    discriminator.add(Dense(512))
    discriminator.add(LeakyReLU(0.2))
    discriminator.add(Dropout(0.3))

    discriminator.add(Dense(256))
    discriminator.add(LeakyReLU(0.2))
    discriminator.add(Dropout(0.3))

    discriminator.add(Dense(1, activation='sigmoid'))
    discriminator.compile(loss='binary_crossentropy', optimizer='rmsprop')

    discriminator.summary()
    return discriminator
```

```python
def get_gan_network(discriminator, random_dim, generator):
    # We initially set trainable to False since we only want to train either the
    # generator or discriminator at a time
    discriminator.trainable = False
    # gan input (noise) will be 100-dimensional vectors
    gan_input = Input(shape=(random_dim,))
    # the output of the generator (an image)
    x = generator(gan_input)
    # get the output of the discriminator (probability if the image is real or not)
    gan_output = discriminator(x)
    gan = Model(inputs=gan_input, outputs=gan_output)
    gan.compile(loss='binary_crossentropy', optimizer='adam')
    return gan


def train(epochs=1, batch_size=128):
    # Get the training and testing data
    x_train, y_train, x_test, y_test = load_minst_data()
    # Split the training data into batches of size 128
    batch_count = x_train.shape[0] / batch_size

    # Build our GAN netowrk
    generator = get_generator()
    discriminator = get_discriminator()
    gan = get_gan_network(discriminator, random_dim, generator)

    for e in range(1, epochs+1):
        print('-'*15, 'Epoch %d' % e, '-'*15)
        for _ in tqdm(range(int(batch_count))):
            # Get a random set of input noise and images
            noise = np.random.normal(0, 1, size=[batch_size, random_dim])
            image_batch = x_train[np.random.randint(0, x_train.shape[0], size=batch_size)]

            # Generate fake MNIST images
            generated_images = generator.predict(noise)
            X = np.concatenate([image_batch, generated_images])

            # Labels for generated and real data
            y_dis = np.zeros(2*batch_size)
            # One-sided label smoothing
            y_dis[:batch_size] = 0.9

            # Train discriminator
            discriminator.trainable = True
            discriminator.train_on_batch(X, y_dis)

            # Train generator
            noise = np.random.normal(0, 1, size=[batch_size, random_dim])
            y_gen = np.ones(batch_size)
            discriminator.trainable = False
            gan.train_on_batch(noise, y_gen)
            generator.save('generator.h5')

        if e == 1 or e % 20 == 0:
            plot_generated_images(e, generator)


def plot_generated_images(epoch, generator, examples=100, dim=(10, 10), figsize=(10, 10)):
    noise = np.random.normal(0, 1, size=[examples, random_dim])
    generated_images = generator.predict(noise)
    generated_images = generated_images.reshape(examples, 28, 28)

    plt.figure(figsize=figsize)
    for i in range(generated_images.shape[0]):
        plt.subplot(dim[0], dim[1], i+1)
        plt.imshow(generated_images[i], interpolation='nearest', cmap='gray_r')
        plt.axis('off')
    plt.tight_layout()
    plt.savefig('gan_generated_image_epoch_%d.png' % epoch)


train()
```

```
Model: "sequential_2"
_____
 Layer (type)                Output Shape              Param #
=================================================================
 dense_8 (Dense)             (None, 256)               25856

 leaky_re_lu_6 (LeakyReLU)   (None, 256)               0

 dense_9 (Dense)             (None, 512)               131584

 leaky_re_lu_7 (LeakyReLU)   (None, 512)               0

 dense_10 (Dense)            (None, 1024)              525312

 leaky_re_lu_8 (LeakyReLU)   (None, 1024)              0

 dense_11 (Dense)            (None, 784)               803600

=================================================================
Total params: 1486352 (5.67 MB)
Trainable params: 1486352 (5.67 MB)
Non-trainable params: 0 (0.00 Byte)
_____
Model: "sequential_3"
_____
 Layer (type)                Output Shape              Param #
=================================================================
 dense_12 (Dense)            (None, 1024)              803840

 leaky_re_lu_9 (LeakyReLU)   (None, 1024)              0

 dropout_3 (Dropout)         (None, 1024)              0

 dense_13 (Dense)            (None, 512)               524800

 leaky_re_lu_10 (LeakyReLU)  (None, 512)               0

 dropout_4 (Dropout)         (None, 512)               0

 dense_14 (Dense)            (None, 256)               131328

 leaky_re_lu_11 (LeakyReLU)  (None, 256)               0

 dropout_5 (Dropout)         (None, 256)               0

 dense_15 (Dense)            (None, 1)                 257

=================================================================
Total params: 1460225 (5.57 MB)
Trainable params: 1460225 (5.57 MB)
Non-trainable params: 0 (0.00 Byte)
_____
--------------- Epoch 1 ---------------
  0%|         | 0/468 [00:00<?, ?it/s]4/4 [==============================] - 0s 6ms/step
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3103: UserWarning: You are saving your model as an HDF5 file via
  saving_api.save_model(
  0%|         | 1/468 [00:02<16:11,  2.08s/it]4/4 [==============================] - 0s 8ms/step
  0%|         | 2/468 [00:02<08:37,  1.11s/it]4/4 [==============================] - 0s 9ms/step
  1%|         | 3/468 [00:02<05:54,  1.31it/s]4/4 [==============================] - 0s 9ms/step
  1%|         | 4/468 [00:03<04:39,  1.66it/s]4/4 [==============================] - 0s 8ms/step
  1%|         | 5/468 [00:03<04:09,  1.85it/s]4/4 [==============================] - 0s 7ms/step
  1%||        | 6/468 [00:04<03:41,  2.09it/s]4/4 [==============================] - 0s 6ms/step
  1%||        | 7/468 [00:04<03:09,  2.44it/s]4/4 [==============================] - 0s 5ms/step
  2%||        | 8/468 [00:04<02:43,  2.81it/s]4/4 [==============================] - 0s 6ms/step
  2%||        | 9/468 [00:04<02:30,  3.04it/s]4/4 [==============================] - 0s 6ms/step
  2%||        | 10/468 [00:05<02:21,  3.23it/s]4/4 [==============================] - 0s 10ms/step
  2%||        | 11/468 [00:05<02:14,  3.39it/s]4/4 [==============================] - 0s 6ms/step
  3%||        | 12/468 [00:05<02:06,  3.60it/s]4/4 [==============================] - 0s 5ms/step
  3%||        | 13/468 [00:05<02:06,  3.61it/s]4/4 [==============================] - 0s 5ms/step
  3%||        | 14/468 [00:06<02:04,  3.66it/s]4/4 [==============================] - 0s 9ms/step
  3%||        | 15/468 [00:06<02:02,  3.71it/s]4/4 [==============================] - 0s 5ms/step
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  4%||        | 19/468 [00:07<01:58,  3.79it/s]4/4 [==============================] - 0s 6ms/step
  4%||        | 20/468 [00:07<01:55,  3.87it/s]4/4 [==============================] - 0s 6ms/step
  4%||        | 21/468 [00:07<01:56,  3.84it/s]4/4 [==============================] - 0s 6ms/step
  5%||        | 22/468 [00:08<01:56,  3.82it/s]4/4 [==============================] - 0s 7ms/step
  5%||        | 23/468 [00:08<01:54,  3.88it/s]4/4 [==============================] - 0s 6ms/step
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  6%||        | 28/468 [00:09<01:47,  4.11it/s]4/4 [==============================] - 0s 6ms/step
```

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 6%|█      | 29/468 [00:09<01:50,  3.99it/s]4/4 [==============================] - 0s 6ms/step
 6%|█      | 30/468 [00:10<01:49,  4.00it/s]4/4 [==============================] - 0s 5ms/step
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 7%|█      | 34/468 [00:11<01:54,  3.79it/s]4/4 [==============================] - 0s 6ms/step
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18%|█      | 84/468 [00:25<01:45,  3.63it/s]4/4 [==============================] - 0s 6ms/step
18%|█      | 85/468 [00:25<01:45,  3.64it/s]4/4 [==============================] - 0s 6ms/step
18%|█      | 86/468 [00:25<01:40,  3.79it/s]4/4 [==============================] - 0s 6ms/step
19%|█      | 87/468 [00:25<01:40,  3.78it/s]4/4 [==============================] - 0s 6ms/step
19%|█      | 88/468 [00:26<01:42,  3.69it/s]4/4 [==============================] - 0s 10ms/step
19%|█      | 89/468 [00:26<01:52,  3.36it/s]4/4 [==============================] - 0s 7ms/step
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19%|█      | 91/468 [00:27<02:08,  2.92it/s]4/4 [==============================] - 0s 10ms/step
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21%|██     | 100/468 [00:29<01:41,  3.61it/s]4/4 [==============================] - 0s 5ms/step
22%|██     | 101/468 [00:30<01:39,  3.69it/s]4/4 [==============================] - 0s 6ms/step
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22%|██     | 103/468 [00:30<01:33,  3.88it/s]4/4 [==============================] - 0s 6ms/step
22%|██     | 104/468 [00:30<01:33,  3.91it/s]4/4 [==============================] - 0s 12ms/step
22%|██     | 105/468 [00:31<01:33,  3.86it/s]4/4 [==============================] - 0s 6ms/step
23%|██     | 106/468 [00:31<01:34,  3.82it/s]4/4 [==============================] - 0s 6ms/step
23%|██     | 107/468 [00:31<01:32,  3.90it/s]4/4 [==============================] - 0s 6ms/step
23%|██     | 108/468 [00:31<01:32,  3.91it/s]4/4 [==============================] - 0s 9ms/step
23%|██     | 109/468 [00:32<01:32,  3.88it/s]4/4 [==============================] - 0s 6ms/step
24%|██     | 110/468 [00:32<01:33,  3.84it/s]4/4 [==============================] - 0s 6ms/step
24%|██     | 111/468 [00:32<01:33,  3.80it/s]4/4 [==============================] - 0s 6ms/step
24%|██     | 112/468 [00:32<01:31,  3.91it/s]4/4 [==============================] - 0s 10ms/step
24%|██     | 113/468 [00:33<01:32,  3.84it/s]4/4 [==============================] - 0s 6ms/step
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25%|███        | 115/468 [00:33<01:27,  4.01it/s]4/4 [==============================] - 0s 6ms/step
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25%|███        | 117/468 [00:34<01:28,  3.99it/s]4/4 [==============================] - 0s 6ms/step
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27%|███        | 125/468 [00:36<01:29,  3.81it/s]4/4 [==============================] - 0s 6ms/step
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27%|███        | 128/468 [00:37<01:27,  3.86it/s]4/4 [==============================] - 0s 7ms/step
28%|███        | 129/468 [00:37<01:28,  3.84it/s]4/4 [==============================] - 0s 6ms/step
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28%|███        | 131/468 [00:37<01:25,  3.96it/s]4/4 [==============================] - 0s 6ms/step
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30%|███        | 142/468 [00:41<01:31,  3.56it/s]4/4 [==============================] - 0s 6ms/step
31%|███        | 143/468 [00:41<01:31,  3.56it/s]4/4 [==============================] - 0s 6ms/step
31%|███        | 144/468 [00:41<01:27,  3.71it/s]4/4 [==============================] - 0s 6ms/step
31%|███        | 145/468 [00:42<01:27,  3.70it/s]4/4 [==============================] - 0s 6ms/step
31%|███        | 146/468 [00:42<01:26,  3.72it/s]4/4 [==============================] - 0s 6ms/step
31%|███        | 147/468 [00:42<01:28,  3.65it/s]4/4 [==============================] - 0s 6ms/step
32%|███        | 148/468 [00:42<01:25,  3.75it/s]4/4 [==============================] - 0s 6ms/step
32%|███        | 149/468 [00:43<01:26,  3.69it/s]4/4 [==============================] - 0s 6ms/step
32%|███        | 150/468 [00:43<01:24,  3.78it/s]4/4 [==============================] - 0s 6ms/step
32%|███        | 151/468 [00:43<01:24,  3.76it/s]4/4 [==============================] - 0s 6ms/step
32%|███        | 152/468 [00:44<01:23,  3.77it/s]4/4 [==============================] - 0s 6ms/step
33%|███        | 153/468 [00:44<01:24,  3.73it/s]4/4 [==============================] - 0s 6ms/step
33%|███        | 154/468 [00:44<01:22,  3.79it/s]4/4 [==============================] - 0s 6ms/step
33%|███        | 155/468 [00:44<01:23,  3.75it/s]4/4 [==============================] - 0s 7ms/step
33%|███        | 156/468 [00:45<01:22,  3.80it/s]4/4 [==============================] - 0s 6ms/step
34%|███        | 157/468 [00:45<01:21,  3.81it/s]4/4 [==============================] - 0s 6ms/step
34%|███        | 158/468 [00:45<01:23,  3.71it/s]4/4 [==============================] - 0s 6ms/step
34%|███        | 159/468 [00:45<01:22,  3.74it/s]4/4 [==============================] - 0s 6ms/step
34%|███        | 160/468 [00:46<01:20,  3.82it/s]4/4 [==============================] - 0s 6ms/step
34%|███        | 161/468 [00:46<01:21,  3.74it/s]4/4 [==============================] - 0s 6ms/step
35%|███        | 162/468 [00:46<01:22,  3.72it/s]4/4 [==============================] - 0s 6ms/step
35%|███        | 163/468 [00:47<01:22,  3.68it/s]4/4 [==============================] - 0s 7ms/step
35%|███        | 164/468 [00:47<01:22,  3.67it/s]4/4 [==============================] - 0s 7ms/step
35%|███        | 165/468 [00:47<01:23,  3.64it/s]4/4 [==============================] - 0s 6ms/step
35%|███        | 166/468 [00:47<01:24,  3.56it/s]4/4 [==============================] - 0s 6ms/step
36%|███        | 167/468 [00:48<01:24,  3.58it/s]4/4 [==============================] - 0s 7ms/step
36%|███        | 168/468 [00:48<01:24,  3.55it/s]4/4 [==============================] - 0s 6ms/step
36%|███        | 169/468 [00:48<01:24,  3.53it/s]4/4 [==============================] - 0s 7ms/step
36%|███        | 170/468 [00:48<01:22,  3.60it/s]4/4 [==============================] - 0s 6ms/step
37%|███        | 171/468 [00:49<01:21,  3.64it/s]4/4 [==============================] - 0s 6ms/step
37%|███        | 172/468 [00:49<01:20,  3.67it/s]4/4 [==============================] - 0s 6ms/step
37%|███        | 173/468 [00:49<01:21,  3.63it/s]4/4 [==============================] - 0s 6ms/step
37%|███        | 174/468 [00:50<01:20,  3.66it/s]4/4 [==============================] - 0s 7ms/step
37%|███        | 175/468 [00:50<01:27,  3.34it/s]4/4 [==============================] - 0s 8ms/step
38%|███        | 176/468 [00:50<01:35,  3.06it/s]4/4 [==============================] - 0s 11ms/step
38%|███        | 177/468 [00:51<01:38,  2.96it/s]4/4 [==============================] - 0s 9ms/step
38%|███        | 178/468 [00:51<01:39,  2.93it/s]4/4 [==============================] - 0s 10ms/step
38%|███        | 179/468 [00:51<01:42,  2.81it/s]4/4 [==============================] - 0s 10ms/step
38%|███        | 180/468 [00:52<01:43,  2.78it/s]4/4 [==============================] - 0s 6ms/step
39%|███        | 181/468 [00:52<01:33,  3.08it/s]4/4 [==============================] - 0s 6ms/step
39%|███        | 182/468 [00:52<01:25,  3.33it/s]4/4 [==============================] - 0s 6ms/step
39%|███        | 183/468 [00:53<01:21,  3.48it/s]4/4 [==============================] - 0s 6ms/step
39%|███        | 184/468 [00:53<01:20,  3.53it/s]4/4 [==============================] - 0s 6ms/step
40%|███        | 185/468 [00:53<01:20,  3.49it/s]4/4 [==============================] - 0s 6ms/step
40%|███        | 186/468 [00:53<01:20,  3.49it/s]4/4 [==============================] - 0s 6ms/step
40%|███        | 187/468 [00:54<01:19,  3.54it/s]4/4 [==============================] - 0s 6ms/step
40%|███        | 188/468 [00:54<01:15,  3.70it/s]4/4 [==============================] - 0s 6ms/step
40%|███        | 189/468 [00:54<01:12,  3.83it/s]4/4 [==============================] - 0s 6ms/step
41%|███        | 190/468 [00:54<01:11,  3.87it/s]4/4 [==============================] - 0s 6ms/step
41%|███        | 191/468 [00:55<01:10,  3.94it/s]4/4 [==============================] - 0s 6ms/step
41%|███        | 192/468 [00:55<01:11,  3.85it/s]4/4 [==============================] - 0s 6ms/step
41%|███        | 193/468 [00:55<01:09,  3.93it/s]4/4 [==============================] - 0s 7ms/step
41%|███        | 194/468 [00:55<01:12,  3.79it/s]4/4 [==============================] - 0s 7ms/step
42%|███        | 195/468 [00:56<01:10,  3.85it/s]4/4 [==============================] - 0s 6ms/step
42%|███        | 196/468 [00:56<01:09,  3.94it/s]4/4 [==============================] - 0s 7ms/step
42%|███        | 197/468 [00:56<01:08,  3.96it/s]4/4 [==============================] - 0s 6ms/step
42%|███        | 198/468 [00:56<01:09,  3.89it/s]4/4 [==============================] - 0s 8ms/step
```

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43%|███████        | 199/468 [00:57<01:11,  3.79it/s]4/4 [==============================] - 0s 7ms/step
43%|███████        | 200/468 [00:57<01:11,  3.75it/s]4/4 [==============================] - 0s 6ms/step
43%|███████        | 201/468 [00:57<01:09,  3.83it/s]4/4 [==============================] - 0s 6ms/step
43%|███████        | 202/468 [00:57<01:08,  3.86it/s]4/4 [==============================] - 0s 6ms/step
43%|███████        | 203/468 [00:58<01:10,  3.78it/s]4/4 [==============================] - 0s 6ms/step
44%|███████        | 204/468 [00:58<01:10,  3.73it/s]4/4 [==============================] - 0s 7ms/step
44%|███████        | 205/468 [00:58<01:11,  3.70it/s]4/4 [==============================] - 0s 6ms/step
44%|███████        | 206/468 [00:59<01:10,  3.74it/s]4/4 [==============================] - 0s 7ms/step
44%|███████        | 207/468 [00:59<01:08,  3.81it/s]4/4 [==============================] - 0s 7ms/step
44%|███████        | 208/468 [00:59<01:06,  3.91it/s]4/4 [==============================] - 0s 7ms/step
45%|███████        | 209/468 [00:59<01:07,  3.81it/s]4/4 [==============================] - 0s 8ms/step
45%|███████        | 210/468 [01:00<01:08,  3.77it/s]4/4 [==============================] - 0s 7ms/step
45%|███████        | 211/468 [01:00<01:08,  3.73it/s]4/4 [==============================] - 0s 7ms/step
45%|███████        | 212/468 [01:00<01:06,  3.82it/s]4/4 [==============================] - 0s 6ms/step
46%|███████        | 213/468 [01:00<01:07,  3.77it/s]4/4 [==============================] - 0s 6ms/step
46%|███████        | 214/468 [01:01<01:07,  3.76it/s]4/4 [==============================] - 0s 6ms/step
46%|███████        | 215/468 [01:01<01:05,  3.87it/s]4/4 [==============================] - 0s 7ms/step
46%|███████        | 216/468 [01:01<01:04,  3.92it/s]4/4 [==============================] - 0s 7ms/step
46%|███████        | 217/468 [01:01<01:06,  3.75it/s]4/4 [==============================] - 0s 6ms/step
47%|███████        | 218/468 [01:02<01:07,  3.69it/s]4/4 [==============================] - 0s 9ms/step
47%|███████        | 219/468 [01:02<01:16,  3.26it/s]4/4 [==============================] - 0s 11ms/step
47%|███████        | 220/468 [01:03<01:20,  3.07it/s]4/4 [==============================] - 0s 19ms/step
47%|███████        | 221/468 [01:04<02:12,  1.86it/s]4/4 [==============================] - 0s 11ms/step
47%|███████        | 222/468 [01:04<02:33,  1.61it/s]4/4 [==============================] - 0s 6ms/step
48%|███████        | 223/468 [01:05<02:27,  1.66it/s]4/4 [==============================] - 0s 7ms/step
48%|███████        | 224/468 [01:05<02:01,  2.01it/s]4/4 [==============================] - 0s 7ms/step
48%|███████        | 225/468 [01:05<01:44,  2.32it/s]4/4 [==============================] - 0s 6ms/step
48%|███████        | 226/468 [01:06<01:30,  2.67it/s]4/4 [==============================] - 0s 6ms/step
49%|███████        | 227/468 [01:06<01:23,  2.89it/s]4/4 [==============================] - 0s 6ms/step
49%|███████        | 228/468 [01:06<01:17,  3.10it/s]4/4 [==============================] - 0s 6ms/step
49%|███████        | 229/468 [01:06<01:11,  3.34it/s]4/4 [==============================] - 0s 6ms/step
49%|███████        | 230/468 [01:07<01:09,  3.44it/s]4/4 [==============================] - 0s 10ms/step
49%|███████        | 231/468 [01:07<01:08,  3.46it/s]4/4 [==============================] - 0s 6ms/step
50%|███████        | 232/468 [01:07<01:07,  3.52it/s]4/4 [==============================] - 0s 7ms/step
50%|███████        | 233/468 [01:08<01:05,  3.56it/s]4/4 [==============================] - 0s 6ms/step
50%|███████        | 234/468 [01:08<01:05,  3.57it/s]4/4 [==============================] - 0s 6ms/step
50%|███████        | 235/468 [01:08<01:03,  3.66it/s]4/4 [==============================] - 0s 7ms/step
50%|███████        | 236/468 [01:08<01:01,  3.77it/s]4/4 [==============================] - 0s 7ms/step
51%|███████        | 237/468 [01:09<01:01,  3.75it/s]4/4 [==============================] - 0s 6ms/step
51%|███████        | 238/468 [01:09<00:59,  3.86it/s]4/4 [==============================] - 0s 6ms/step
51%|███████        | 239/468 [01:09<01:01,  3.72it/s]4/4 [==============================] - 0s 7ms/step
51%|███████        | 240/468 [01:09<01:02,  3.66it/s]4/4 [==============================] - 0s 6ms/step
51%|███████        | 241/468 [01:10<01:00,  3.78it/s]4/4 [==============================] - 0s 6ms/step
52%|███████        | 242/468 [01:10<01:01,  3.69it/s]4/4 [==============================] - 0s 6ms/step
52%|███████        | 243/468 [01:10<00:58,  3.82it/s]4/4 [==============================] - 0s 6ms/step
52%|███████        | 244/468 [01:10<00:59,  3.75it/s]4/4 [==============================] - 0s 7ms/step
52%|███████        | 245/468 [01:11<01:00,  3.70it/s]4/4 [==============================] - 0s 6ms/step
53%|███████        | 246/468 [01:11<00:59,  3.76it/s]4/4 [==============================] - 0s 6ms/step
53%|███████        | 247/468 [01:11<00:57,  3.83it/s]4/4 [==============================] - 0s 6ms/step
53%|███████        | 248/468 [01:12<00:55,  3.94it/s]4/4 [==============================] - 0s 7ms/step
53%|███████        | 249/468 [01:12<00:56,  3.87it/s]4/4 [==============================] - 0s 6ms/step
53%|███████        | 250/468 [01:12<00:58,  3.75it/s]4/4 [==============================] - 0s 7ms/step
54%|███████        | 251/468 [01:12<00:57,  3.78it/s]4/4 [==============================] - 0s 7ms/step
54%|███████        | 252/468 [01:13<00:57,  3.74it/s]4/4 [==============================] - 0s 6ms/step
54%|███████        | 253/468 [01:13<00:56,  3.80it/s]4/4 [==============================] - 0s 6ms/step
54%|███████        | 254/468 [01:13<00:56,  3.80it/s]4/4 [==============================] - 0s 6ms/step
54%|███████        | 255/468 [01:13<00:56,  3.74it/s]4/4 [==============================] - 0s 6ms/step
55%|███████        | 256/468 [01:14<00:55,  3.82it/s]4/4 [==============================] - 0s 6ms/step
55%|███████        | 257/468 [01:14<00:53,  3.92it/s]4/4 [==============================] - 0s 6ms/step
55%|███████        | 258/468 [01:14<00:58,  3.59it/s]4/4 [==============================] - 0s 12ms/step
55%|███████        | 259/468 [01:15<01:03,  3.29it/s]4/4 [==============================] - 0s 8ms/step
56%|███████        | 260/468 [01:15<01:08,  3.04it/s]4/4 [==============================] - 0s 8ms/step
56%|███████        | 261/468 [01:15<01:15,  2.75it/s]4/4 [==============================] - 0s 9ms/step
56%|███████        | 262/468 [01:16<01:16,  2.71it/s]4/4 [==============================] - 0s 9ms/step
56%|███████        | 263/468 [01:16<01:14,  2.76it/s]4/4 [==============================] - 0s 6ms/step
56%|███████        | 264/468 [01:16<01:09,  2.95it/s]4/4 [==============================] - 0s 7ms/step
57%|███████        | 265/468 [01:17<01:05,  3.12it/s]4/4 [==============================] - 0s 6ms/step
57%|███████        | 266/468 [01:17<01:02,  3.24it/s]4/4 [==============================] - 0s 10ms/step
57%|███████        | 267/468 [01:17<01:00,  3.35it/s]4/4 [==============================] - 0s 6ms/step
57%|███████        | 268/468 [01:18<00:56,  3.51it/s]4/4 [==============================] - 0s 7ms/step
57%|███████        | 269/468 [01:18<00:54,  3.68it/s]4/4 [==============================] - 0s 7ms/step
58%|███████        | 270/468 [01:18<00:54,  3.63it/s]4/4 [==============================] - 0s 7ms/step
58%|███████        | 271/468 [01:18<00:54,  3.60it/s]4/4 [==============================] - 0s 7ms/step
58%|███████        | 272/468 [01:19<00:54,  3.62it/s]4/4 [==============================] - 0s 6ms/step
58%|███████        | 273/468 [01:19<00:55,  3.51it/s]4/4 [==============================] - 0s 8ms/step
59%|███████        | 274/468 [01:19<00:54,  3.54it/s]4/4 [==============================] - 0s 8ms/step
59%|███████        | 275/468 [01:19<00:54,  3.55it/s]4/4 [==============================] - 0s 6ms/step
59%|███████        | 276/468 [01:20<00:52,  3.67it/s]4/4 [==============================] - 0s 7ms/step
59%|███████        | 277/468 [01:20<00:50,  3.76it/s]4/4 [==============================] - 0s 6ms/step
59%|███████        | 278/468 [01:20<00:51,  3.66it/s]4/4 [==============================] - 0s 6ms/step
60%|███████        | 279/468 [01:21<00:52,  3.60it/s]4/4 [==============================] - 0s 7ms/step
60%|███████        | 280/468 [01:21<00:52,  3.60it/s]4/4 [==============================] - 0s 6ms/step
60%|███████        | 281/468 [01:21<01:09,  2.68it/s]4/4 [==============================] - 0s 6ms/step
60%|███████        | 282/468 [01:22<01:09,  2.66it/s]4/4 [==============================] - 0s 6ms/step
60%|███████        | 283/468 [01:22<01:02,  2.94it/s]4/4 [==============================] - 0s 19ms/step
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60%|          | 283/468 [01:22<01:02,  2.94it/s]4/4 [==============================] - 0s 19ms/step
61%|          | 284/468 [01:23<01:20,  2.28it/s]4/4 [==============================] - 0s 6ms/step
61%|          | 285/468 [01:23<01:12,  2.53it/s]4/4 [==============================] - 0s 6ms/step
61%|          | 286/468 [01:23<01:05,  2.78it/s]4/4 [==============================] - 0s 6ms/step
61%|          | 287/468 [01:24<00:59,  3.04it/s]4/4 [==============================] - 0s 6ms/step
62%|          | 288/468 [01:24<00:56,  3.19it/s]4/4 [==============================] - 0s 7ms/step
62%|          | 289/468 [01:24<00:53,  3.36it/s]4/4 [==============================] - 0s 6ms/step
62%|          | 290/468 [01:24<00:49,  3.57it/s]4/4 [==============================] - 0s 6ms/step
62%|          | 291/468 [01:25<00:49,  3.59it/s]4/4 [==============================] - 0s 7ms/step
62%|          | 292/468 [01:25<00:48,  3.64it/s]4/4 [==============================] - 0s 7ms/step
63%|          | 293/468 [01:25<00:46,  3.74it/s]4/4 [==============================] - 0s 6ms/step
63%|          | 294/468 [01:25<00:47,  3.69it/s]4/4 [==============================] - 0s 7ms/step
63%|          | 295/468 [01:26<00:47,  3.63it/s]4/4 [==============================] - 0s 7ms/step
63%|          | 296/468 [01:26<00:47,  3.63it/s]4/4 [==============================] - 0s 10ms/step
63%|          | 297/468 [01:26<00:50,  3.40it/s]4/4 [==============================] - 0s 9ms/step
64%|          | 298/468 [01:27<00:54,  3.13it/s]4/4 [==============================] - 0s 8ms/step
64%|          | 299/468 [01:27<00:56,  2.97it/s]4/4 [==============================] - 0s 10ms/step
64%|          | 300/468 [01:27<01:01,  2.75it/s]4/4 [==============================] - 0s 12ms/step
64%|          | 301/468 [01:28<01:06,  2.51it/s]4/4 [==============================] - 0s 6ms/step
65%|          | 302/468 [01:28<01:01,  2.69it/s]4/4 [==============================] - 0s 6ms/step
65%|          | 303/468 [01:29<00:56,  2.93it/s]4/4 [==============================] - 0s 9ms/step
65%|          | 304/468 [01:29<00:52,  3.13it/s]4/4 [==============================] - 0s 6ms/step
65%|          | 305/468 [01:29<00:49,  3.30it/s]4/4 [==============================] - 0s 7ms/step
65%|          | 306/468 [01:29<00:48,  3.36it/s]4/4 [==============================] - 0s 6ms/step
66%|          | 307/468 [01:30<00:46,  3.45it/s]4/4 [==============================] - 0s 6ms/step
66%|          | 308/468 [01:30<00:44,  3.57it/s]4/4 [==============================] - 0s 7ms/step
66%|          | 309/468 [01:30<00:44,  3.59it/s]4/4 [==============================] - 0s 6ms/step
66%|          | 310/468 [01:30<00:43,  3.62it/s]4/4 [==============================] - 0s 6ms/step
66%|          | 311/468 [01:31<00:44,  3.56it/s]4/4 [==============================] - 0s 7ms/step
67%|          | 312/468 [01:31<00:44,  3.53it/s]4/4 [==============================] - 0s 6ms/step
67%|          | 313/468 [01:31<00:42,  3.62it/s]4/4 [==============================] - 0s 6ms/step
67%|          | 314/468 [01:32<00:41,  3.72it/s]4/4 [==============================] - 0s 7ms/step
67%|          | 315/468 [01:32<00:41,  3.72it/s]4/4 [==============================] - 0s 6ms/step
68%|          | 316/468 [01:32<00:39,  3.80it/s]4/4 [==============================] - 0s 7ms/step
68%|          | 317/468 [01:32<00:40,  3.73it/s]4/4 [==============================] - 0s 7ms/step
68%|          | 318/468 [01:33<00:39,  3.81it/s]4/4 [==============================] - 0s 6ms/step
68%|          | 319/468 [01:33<00:40,  3.70it/s]4/4 [==============================] - 0s 6ms/step
68%|          | 320/468 [01:33<00:40,  3.70it/s]4/4 [==============================] - 0s 7ms/step
69%|          | 321/468 [01:33<00:39,  3.70it/s]4/4 [==============================] - 0s 6ms/step
69%|          | 322/468 [01:34<00:40,  3.60it/s]4/4 [==============================] - 0s 10ms/step
69%|          | 323/468 [01:34<00:40,  3.59it/s]4/4 [==============================] - 0s 7ms/step
69%|          | 324/468 [01:34<00:39,  3.67it/s]4/4 [==============================] - 0s 6ms/step
69%|          | 325/468 [01:34<00:38,  3.76it/s]4/4 [==============================] - 0s 6ms/step
70%|          | 326/468 [01:35<00:37,  3.75it/s]4/4 [==============================] - 0s 10ms/step
70%|          | 327/468 [01:35<00:37,  3.71it/s]4/4 [==============================] - 0s 7ms/step
70%|          | 328/468 [01:35<00:37,  3.76it/s]4/4 [==============================] - 0s 8ms/step
70%|          | 329/468 [01:36<00:37,  3.71it/s]4/4 [==============================] - 0s 7ms/step
71%|          | 330/468 [01:36<00:37,  3.71it/s]4/4 [==============================] - 0s 7ms/step
71%|          | 331/468 [01:36<00:36,  3.77it/s]4/4 [==============================] - 0s 7ms/step
71%|          | 332/468 [01:36<00:35,  3.82it/s]4/4 [==============================] - 0s 8ms/step
71%|          | 333/468 [01:37<00:35,  3.79it/s]4/4 [==============================] - 0s 6ms/step
71%|          | 334/468 [01:37<00:34,  3.86it/s]4/4 [==============================] - 0s 7ms/step
72%|          | 335/468 [01:37<00:35,  3.75it/s]4/4 [==============================] - 0s 6ms/step
72%|          | 336/468 [01:37<00:34,  3.83it/s]4/4 [==============================] - 0s 6ms/step
72%|          | 337/468 [01:38<00:34,  3.76it/s]4/4 [==============================] - 0s 7ms/step
72%|          | 338/468 [01:38<00:35,  3.71it/s]4/4 [==============================] - 0s 6ms/step
72%|          | 339/468 [01:38<00:38,  3.39it/s]4/4 [==============================] - 0s 11ms/step
73%|          | 340/468 [01:39<00:41,  3.07it/s]4/4 [==============================] - 0s 10ms/step
73%|          | 341/468 [01:39<00:44,  2.84it/s]4/4 [==============================] - 0s 10ms/step
73%|          | 342/468 [01:40<01:08,  1.83it/s]4/4 [==============================] - 0s 6ms/step
73%|          | 343/468 [01:40<00:58,  2.15it/s]4/4 [==============================] - 0s 7ms/step
74%|          | 344/468 [01:41<00:49,  2.49it/s]4/4 [==============================] - 0s 6ms/step
74%|          | 345/468 [01:41<00:43,  2.80it/s]4/4 [==============================] - 0s 6ms/step
74%|          | 346/468 [01:41<00:40,  3.05it/s]4/4 [==============================] - 0s 6ms/step
74%|          | 347/468 [01:41<00:37,  3.19it/s]4/4 [==============================] - 0s 7ms/step
74%|          | 348/468 [01:42<00:36,  3.30it/s]4/4 [==============================] - 0s 6ms/step
75%|          | 349/468 [01:42<00:35,  3.39it/s]4/4 [==============================] - 0s 6ms/step
75%|          | 350/468 [01:42<00:35,  3.36it/s]4/4 [==============================] - 0s 7ms/step
75%|          | 351/468 [01:43<00:33,  3.50it/s]4/4 [==============================] - 0s 8ms/step
75%|          | 352/468 [01:43<00:32,  3.60it/s]4/4 [==============================] - 0s 6ms/step
75%|          | 353/468 [01:43<00:30,  3.74it/s]4/4 [==============================] - 0s 6ms/step
76%|          | 354/468 [01:43<00:31,  3.67it/s]4/4 [==============================] - 0s 7ms/step
76%|          | 355/468 [01:44<00:29,  3.79it/s]4/4 [==============================] - 0s 6ms/step
76%|          | 356/468 [01:44<00:30,  3.72it/s]4/4 [==============================] - 0s 6ms/step
76%|          | 357/468 [01:44<00:30,  3.68it/s]4/4 [==============================] - 0s 6ms/step
76%|          | 358/468 [01:44<00:29,  3.69it/s]4/4 [==============================] - 0s 7ms/step
77%|          | 359/468 [01:45<00:28,  3.76it/s]4/4 [==============================] - 0s 7ms/step
77%|          | 360/468 [01:45<00:29,  3.68it/s]4/4 [==============================] - 0s 6ms/step
77%|          | 361/468 [01:45<00:28,  3.74it/s]4/4 [==============================] - 0s 10ms/step
77%|          | 362/468 [01:46<00:30,  3.47it/s]4/4 [==============================] - 0s 8ms/step
78%|          | 363/468 [01:46<00:31,  3.36it/s]4/4 [==============================] - 0s 8ms/step
78%|          | 364/468 [01:46<00:32,  3.18it/s]4/4 [==============================] - 0s 9ms/step
78%|          | 365/468 [01:47<00:35,  2.93it/s]4/4 [==============================] - 0s 10ms/step
78%|          | 366/468 [01:47<00:34,  2.98it/s]4/4 [==============================] - 0s 8ms/step
78%|          | 367/468 [01:47<00:34,  2.93it/s]4/4 [==============================] - 0s 7ms/step
```

```
79%|████████████▌          | 368/468 [01:48<00:33,  2.95it/s]4/4 [==============================] - 0s 8ms/step
79%|████████████▌          | 369/468 [01:48<00:33,  2.96it/s]4/4 [==============================] - 0s 8ms/step
79%|████████████▌          | 370/468 [01:48<00:33,  2.92it/s]4/4 [==============================] - 0s 8ms/step
79%|████████████▌          | 371/468 [01:49<00:34,  2.84it/s]4/4 [==============================] - 0s 8ms/step
79%|████████████▌          | 372/468 [01:49<00:33,  2.89it/s]4/4 [==============================] - 0s 11ms/step
80%|████████████▌          | 373/468 [01:49<00:33,  2.85it/s]4/4 [==============================] - 0s 9ms/step
80%|████████████▌          | 374/468 [01:50<00:38,  2.44it/s]4/4 [==============================] - 0s 34ms/step
80%|████████████▌          | 375/468 [01:51<00:54,  1.71it/s]4/4 [==============================] - 0s 24ms/step
80%|████████████▌          | 376/468 [01:52<00:59,  1.55it/s]4/4 [==============================] - 0s 15ms/step
81%|████████████▋          | 377/468 [01:52<00:56,  1.61it/s]4/4 [==============================] - 0s 11ms/step
81%|████████████▋          | 378/468 [01:53<00:57,  1.57it/s]4/4 [==============================] - 0s 21ms/step
81%|████████████▋          | 379/468 [01:54<00:55,  1.60it/s]4/4 [==============================] - 0s 10ms/step
81%|████████████▋          | 380/468 [01:54<00:49,  1.78it/s]4/4 [==============================] - 0s 9ms/step
81%|████████████▋          | 381/468 [01:54<00:43,  1.98it/s]4/4 [==============================] - 0s 6ms/step
82%|████████████▊          | 382/468 [01:55<00:37,  2.27it/s]4/4 [==============================] - 0s 7ms/step
82%|████████████▊          | 383/468 [01:55<00:32,  2.58it/s]4/4 [==============================] - 0s 6ms/step
82%|████████████▊          | 384/468 [01:55<00:30,  2.75it/s]4/4 [==============================] - 0s 7ms/step
82%|████████████▊          | 385/468 [01:55<00:27,  3.01it/s]4/4 [==============================] - 0s 6ms/step
82%|████████████▊          | 386/468 [01:56<00:25,  3.24it/s]4/4 [==============================] - 0s 6ms/step
83%|████████████▉          | 387/468 [01:56<00:24,  3.34it/s]4/4 [==============================] - 0s 9ms/step
83%|████████████▉          | 388/468 [01:56<00:23,  3.39it/s]4/4 [==============================] - 0s 6ms/step
83%|████████████▉          | 389/468 [01:57<00:22,  3.55it/s]4/4 [==============================] - 0s 7ms/step
83%|████████████▉          | 390/468 [01:57<00:22,  3.54it/s]4/4 [==============================] - 0s 7ms/step
84%|████████████▉          | 391/468 [01:57<00:21,  3.62it/s]4/4 [==============================] - 0s 7ms/step
84%|█████████████          | 392/468 [01:57<00:21,  3.56it/s]4/4 [==============================] - 0s 6ms/step
84%|█████████████          | 393/468 [01:58<00:21,  3.53it/s]4/4 [==============================] - 0s 7ms/step
84%|█████████████          | 394/468 [01:58<00:20,  3.60it/s]4/4 [==============================] - 0s 6ms/step
84%|█████████████          | 395/468 [01:58<00:19,  3.65it/s]4/4 [==============================] - 0s 7ms/step
85%|█████████████          | 396/468 [01:58<00:19,  3.70it/s]4/4 [==============================] - 0s 7ms/step
85%|█████████████          | 397/468 [01:59<00:19,  3.69it/s]4/4 [==============================] - 0s 6ms/step
85%|█████████████▏         | 398/468 [01:59<00:18,  3.71it/s]4/4 [==============================] - 0s 7ms/step
85%|█████████████▏         | 399/468 [01:59<00:18,  3.71it/s]4/4 [==============================] - 0s 8ms/step
85%|█████████████▏         | 400/468 [02:00<00:18,  3.73it/s]4/4 [==============================] - 0s 7ms/step
86%|█████████████▏         | 401/468 [02:00<00:18,  3.70it/s]4/4 [==============================] - 0s 7ms/step
86%|█████████████▏         | 402/468 [02:00<00:18,  3.60it/s]4/4 [==============================] - 0s 7ms/step
86%|█████████████▏         | 403/468 [02:00<00:18,  3.53it/s]4/4 [==============================] - 0s 7ms/step
86%|█████████████▎         | 404/468 [02:01<00:17,  3.67it/s]4/4 [==============================] - 0s 6ms/step
87%|█████████████▎         | 405/468 [02:01<00:16,  3.77it/s]4/4 [==============================] - 0s 7ms/step
87%|█████████████▎         | 406/468 [02:01<00:16,  3.80it/s]4/4 [==============================] - 0s 10ms/step
87%|█████████████▎         | 407/468 [02:01<00:16,  3.62it/s]4/4 [==============================] - 0s 6ms/step
87%|█████████████▎         | 408/468 [02:02<00:16,  3.55it/s]4/4 [==============================] - 0s 6ms/step
87%|█████████████▍         | 409/468 [02:02<00:16,  3.57it/s]4/4 [==============================] - 0s 7ms/step
88%|█████████████▍         | 410/468 [02:02<00:16,  3.50it/s]4/4 [==============================] - 0s 8ms/step
88%|█████████████▍         | 411/468 [02:03<00:16,  3.49it/s]4/4 [==============================] - 0s 7ms/step
88%|█████████████▍         | 412/468 [02:03<00:15,  3.56it/s]4/4 [==============================] - 0s 6ms/step
88%|█████████████▍         | 413/468 [02:03<00:14,  3.67it/s]4/4 [==============================] - 0s 6ms/step
88%|█████████████▌         | 414/468 [02:03<00:14,  3.67it/s]4/4 [==============================] - 0s 7ms/step
89%|█████████████▌         | 415/468 [02:04<00:14,  3.64it/s]4/4 [==============================] - 0s 6ms/step
89%|█████████████▌         | 416/468 [02:04<00:13,  3.74it/s]4/4 [==============================] - 0s 7ms/step
89%|█████████████▌         | 417/468 [02:04<00:13,  3.80it/s]4/4 [==============================] - 0s 9ms/step
89%|█████████████▌         | 418/468 [02:05<00:15,  3.24it/s]4/4 [==============================] - 0s 10ms/step
90%|█████████████▋         | 419/468 [02:05<00:16,  3.00it/s]4/4 [==============================] - 0s 12ms/step
90%|█████████████▋         | 420/468 [02:05<00:17,  2.80it/s]4/4 [==============================] - 0s 12ms/step
90%|█████████████▋         | 421/468 [02:06<00:17,  2.72it/s]4/4 [==============================] - 0s 11ms/step
90%|█████████████▋         | 422/468 [02:06<00:17,  2.68it/s]4/4 [==============================] - 0s 12ms/step
90%|█████████████▋         | 423/468 [02:07<00:16,  2.66it/s]4/4 [==============================] - 0s 7ms/step
91%|█████████████▊         | 424/468 [02:07<00:14,  2.97it/s]4/4 [==============================] - 0s 7ms/step
91%|█████████████▊         | 425/468 [02:07<00:13,  3.23it/s]4/4 [==============================] - 0s 7ms/step
91%|█████████████▊         | 426/468 [02:07<00:12,  3.43it/s]4/4 [==============================] - 0s 8ms/step
91%|█████████████▊         | 427/468 [02:08<00:12,  3.40it/s]4/4 [==============================] - 0s 8ms/step
91%|█████████████▉         | 428/468 [02:08<00:11,  3.52it/s]4/4 [==============================] - 0s 6ms/step
92%|█████████████▉         | 429/468 [02:08<00:10,  3.65it/s]4/4 [==============================] - 0s 7ms/step
92%|█████████████▉         | 430/468 [02:08<00:10,  3.71it/s]4/4 [==============================] - 0s 7ms/step
92%|█████████████▉         | 431/468 [02:09<00:10,  3.70it/s]4/4 [==============================] - 0s 6ms/step
92%|█████████████▉         | 432/468 [02:09<00:09,  3.67it/s]4/4 [==============================] - 0s 6ms/step
93%|██████████████         | 433/468 [02:09<00:09,  3.65it/s]4/4 [==============================] - 0s 6ms/step
93%|██████████████         | 434/468 [02:09<00:09,  3.67it/s]4/4 [==============================] - 0s 8ms/step
93%|██████████████         | 435/468 [02:10<00:09,  3.62it/s]4/4 [==============================] - 0s 8ms/step
93%|██████████████         | 436/468 [02:10<00:08,  3.62it/s]4/4 [==============================] - 0s 7ms/step
93%|██████████████         | 437/468 [02:10<00:08,  3.52it/s]4/4 [==============================] - 0s 8ms/step
94%|██████████████▏        | 438/468 [02:11<00:08,  3.46it/s]4/4 [==============================] - 0s 7ms/step
94%|██████████████▏        | 439/468 [02:11<00:08,  3.47it/s]4/4 [==============================] - 0s 7ms/step
94%|██████████████▏        | 440/468 [02:11<00:07,  3.50it/s]4/4 [==============================] - 0s 7ms/step
94%|██████████████▏        | 441/468 [02:11<00:07,  3.62it/s]4/4 [==============================] - 0s 7ms/step
94%|██████████████▏        | 442/468 [02:12<00:07,  3.56it/s]4/4 [==============================] - 0s 7ms/step
95%|██████████████▎        | 443/468 [02:12<00:07,  3.57it/s]4/4 [==============================] - 0s 10ms/step
95%|██████████████▎        | 444/468 [02:12<00:06,  3.56it/s]4/4 [==============================] - 0s 6ms/step
95%|██████████████▎        | 445/468 [02:13<00:06,  3.58it/s]4/4 [==============================] - 0s 7ms/step
95%|██████████████▎        | 446/468 [02:13<00:06,  3.46it/s]4/4 [==============================] - 0s 7ms/step
96%|██████████████▎        | 447/468 [02:13<00:05,  3.50it/s]4/4 [==============================] - 0s 7ms/step
96%|██████████████▍        | 448/468 [02:13<00:05,  3.58it/s]4/4 [==============================] - 0s 7ms/step
96%|██████████████▍        | 449/468 [02:14<00:05,  3.50it/s]4/4 [==============================] - 0s 7ms/step
96%|██████████████▍        | 450/468 [02:14<00:05,  3.53it/s]4/4 [==============================] - 0s 6ms/step
96%|██████████████▍        | 451/468 [02:14<00:04,  3.66it/s]4/4 [==============================] - 0s 6ms/step
97%|██████████████▍        | 452/468 [02:15<00:04,  3.60it/s]4/4 [==============================] - 0s 7ms/step
```

```
 97%|███████    |  453/468 [02:15<00:04,  3.50it/s]4/4 [==============================] - 0s 9ms/step
 97%|███████    |  454/468 [02:15<00:03,  3.54it/s]4/4 [==============================] - 0s 7ms/step
 97%|███████    |  455/468 [02:15<00:03,  3.57it/s]4/4 [==============================] - 0s 7ms/step
 97%|███████    |  456/468 [02:16<00:03,  3.63it/s]4/4 [==============================] - 0s 8ms/step
 98%|███████    |  457/468 [02:16<00:03,  3.59it/s]4/4 [==============================] - 0s 7ms/step
 98%|███████    |  458/468 [02:16<00:02,  3.56it/s]4/4 [==============================] - 0s 7ms/step
 98%|███████    |  459/468 [02:17<00:02,  3.54it/s]4/4 [==============================] - 0s 9ms/step
 98%|███████    |  460/468 [02:17<00:02,  3.08it/s]4/4 [==============================] - 0s 9ms/step
 99%|███████    |  461/468 [02:17<00:02,  2.93it/s]4/4 [==============================] - 0s 7ms/step
 99%|███████    |  462/468 [02:18<00:02,  2.63it/s]4/4 [==============================] - 0s 10ms/step
 99%|███████    |  463/468 [02:18<00:01,  2.60it/s]4/4 [==============================] - 0s 8ms/step
 99%|███████    |  464/468 [02:19<00:01,  2.60it/s]4/4 [==============================] - 0s 9ms/step
 99%|███████    |  465/468 [02:19<00:01,  2.78it/s]4/4 [==============================] - 0s 7ms/step
100%|███████    |  466/468 [02:19<00:00,  3.00it/s]4/4 [==============================] - 0s 8ms/step
100%|███████    |  467/468 [02:19<00:00,  3.13it/s]4/4 [==============================] - 0s 7ms/step
100%|███████    |  468/468 [02:20<00:00,  3.34it/s]4/4 [==============================] - 0s 7ms/step
```
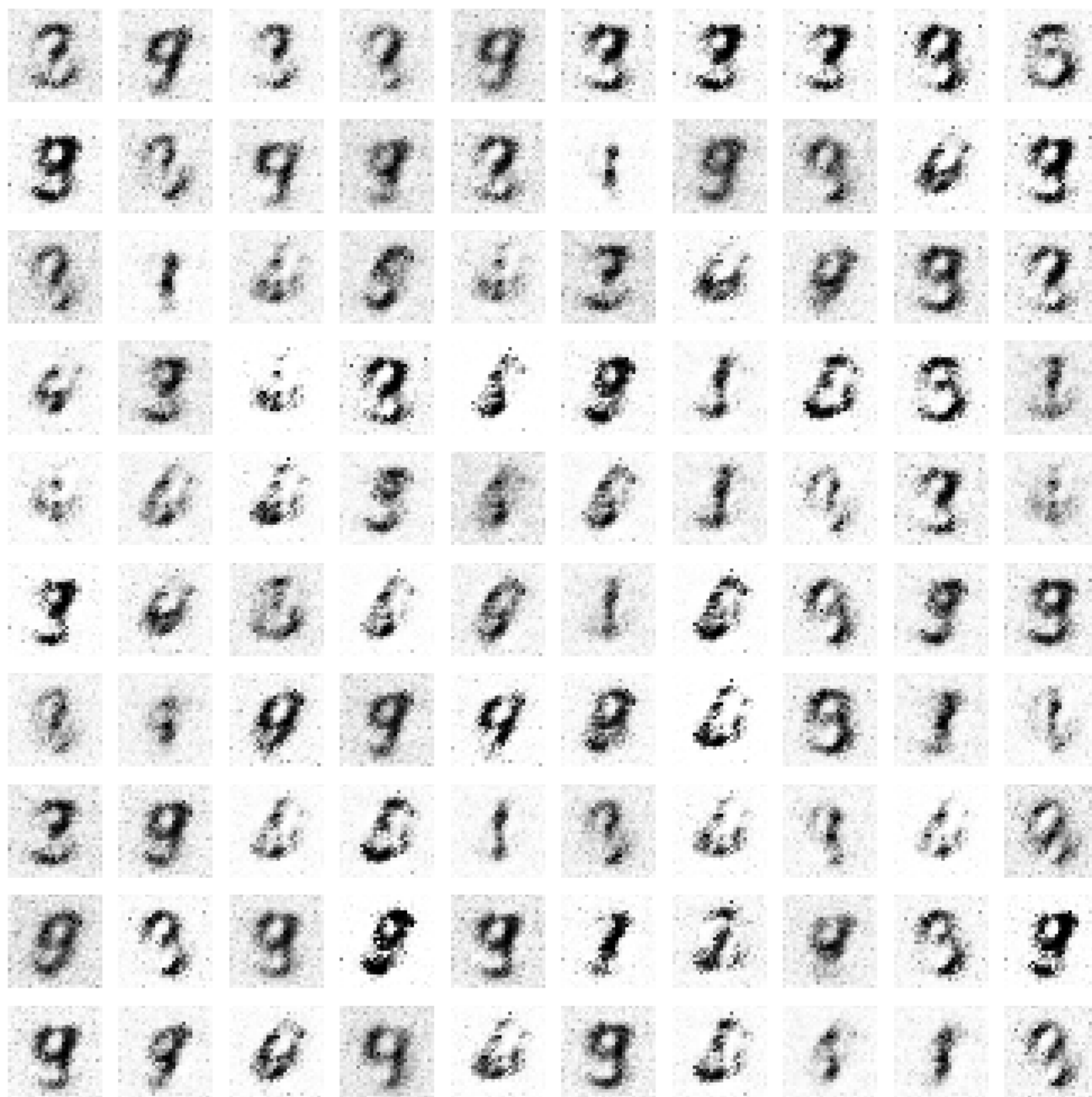
train(epochs=10)

```
  0%|          | 0/468 [00:00<?, ?it/s]Model: "sequential_3"
_____
 Layer (type)                Output Shape              Param #
=================================================================
 dense_9 (Dense)             (None, 256)               25856

 leaky_re_lu_7 (LeakyReLU)   (None, 256)               0

 dense_10 (Dense)            (None, 512)               131584

 leaky_re_lu_8 (LeakyReLU)   (None, 512)               0

 dense_11 (Dense)            (None, 1024)              525312

 leaky_re_lu_9 (LeakyReLU)   (None, 1024)              0

 dense_12 (Dense)            (None, 784)               803600
=================================================================
Total params: 1,486,352
Trainable params: 1,486,352
Non-trainable params: 0
_____
Model: "sequential_4"
_____
 Layer (type)                Output Shape              Param #
=================================================================
 dense_13 (Dense)            (None, 1024)              803840

 leaky_re_lu_10 (LeakyReLU)  (None, 1024)              0

 dropout_4 (Dropout)         (None, 1024)              0

 dense_14 (Dense)            (None, 512)               524800

 leaky_re_lu_11 (LeakyReLU)  (None, 512)               0

 dropout_5 (Dropout)         (None, 512)               0

 dense_15 (Dense)            (None, 256)               131328

 leaky_re_lu_12 (LeakyReLU)  (None, 256)               0

 dropout_6 (Dropout)         (None, 256)               0

 dense_16 (Dense)            (None, 1)                 257
=================================================================
Total params: 1,460,225
Trainable params: 1,460,225
Non-trainable params: 0
_____
-------------- Epoch 1 ---------------
100%|██████████| 468/468 [00:31<00:00, 15.07it/s]
  0%|          | 2/468 [00:00<00:24, 18.76it/s]-------------- Epoch 2 ---------------
100%|██████████| 468/468 [00:29<00:00, 16.07it/s]
  0%|          | 2/468 [00:00<00:26, 17.86it/s]-------------- Epoch 3 ---------------
100%|██████████| 468/468 [00:30<00:00, 15.12it/s]
  0%|          | 2/468 [00:00<00:34, 13.67it/s]-------------- Epoch 4 ---------------
100%|██████████| 468/468 [00:28<00:00, 16.20it/s]
  0%|          | 2/468 [00:00<00:29, 15.97it/s]-------------- Epoch 5 ---------------
100%|██████████| 468/468 [00:29<00:00, 15.69it/s]
  0%|          | 2/468 [00:00<00:31, 14.82it/s]-------------- Epoch 6 ---------------
100%|██████████| 468/468 [00:32<00:00, 14.48it/s]
  0%|          | 2/468 [00:00<00:33, 14.02it/s]-------------- Epoch 7 ---------------
100%|██████████| 468/468 [00:31<00:00, 15.02it/s]
  0%|          | 2/468 [00:00<00:32, 14.44it/s]-------------- Epoch 8 ---------------
100%|██████████| 468/468 [00:31<00:00, 15.03it/s]
  0%|          | 2/468 [00:00<00:30, 15.52it/s]-------------- Epoch 9 ---------------
100%|██████████| 468/468 [00:32<00:00, 14.22it/s]
  0%|          | 2/468 [00:00<00:34, 13.53it/s]-------------- Epoch 10 ---------------
100%|██████████| 468/468 [00:32<00:00, 14.47it/s]
```
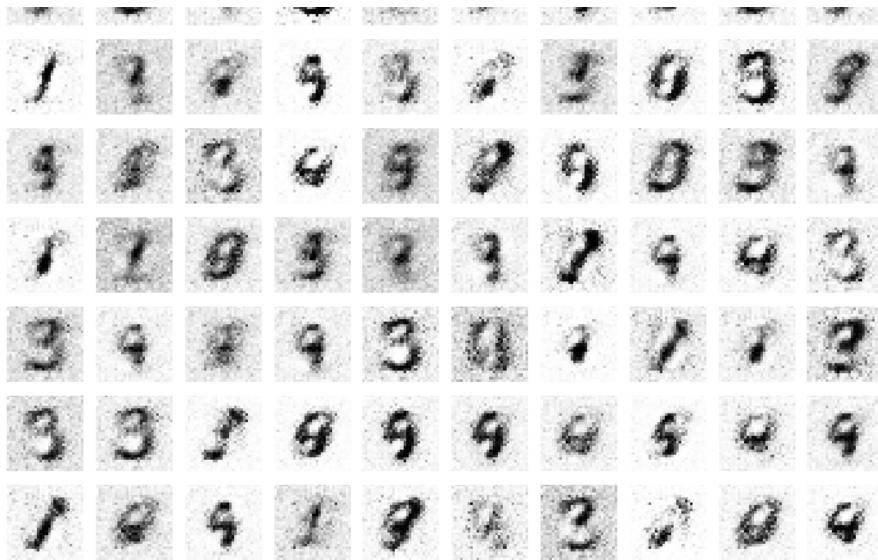
```python
from tensorflow.keras.models import load_model
```

```python
generator = load_model('/content/generator.h5')
```

```python
import numpy as np
n=100
noise = np.random.normal(0, 1, size=[n, random_dim])
# random_noise = np.random.normal(0, 1, (number_of_samples, latent_dim))
generated_images = generator.predict(noise)
```

```
4/4 [==============================] - 0s 5ms/step
```

```python
import matplotlib.pyplot as plt
generated_images = generated_images.reshape(n, 28, 28)

plt.figure(figsize=(10,10))
for i in range(generated_images.shape[0]):
    plt.subplot(10, 10, i+1)
    plt.imshow(generated_images[i], interpolation='nearest', cmap='gray_r')
    plt.axis('off')
plt.tight_layout()
```