GAN on MNIST dataset

```
import keras
import matplotlib.pyplot as plt
```

```
from keras.layers import Input
from keras.models import Model, Sequential
from keras.layers.core import Dense, Dropout
from keras.layers.advanced_activations import LeakyReLU
from keras.datasets import mnist
from keras.optimizers import Adam
from keras import initializers
from tqdm import tqdm
```

```
import numpy as np

# Setting the dimension of a random noise vector.
random_dim = 100
```

```
print(np.random.seed(1000))
```

```
None
```

```
#Using the popular MNIST dataset which contains images of digits from 0–9. It has a training set of 60,000 examples and a te
```

```
def load_minst_data():
  (x_train, y_train), (x_test, y_test) = mnist.load_data()
  x_train=x_train/255                                          # Normalizing values between -1 to 1
  x_train = x_train.reshape(60000, 784)                        # converting 3D to 2D array
  return (x_train, y_train, x_test, y_test)
```

```
optimizer = Adam(lr=0.0002)
```

```
# Generator network

generator = Sequential()
generator.add(Dense(256, input_dim=random_dim, kernel_initializer=initializers.RandomNormal(stddev=0.02)))  # For setting ra
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=optimizer)
```

```
# Discriminator network

discriminator = Sequential()
discriminator.add(Dense(1024, input_dim=784, kernel_initializer=initializers.RandomNormal(stddev=0.02)))   # For setting ran
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=optimizer)
```

```
discriminator.trainable = False  # To train one network at a time, it is set to False
ganInput = Input(shape=(random_dim,))
```

```
x = generator(ganInput)
ganOutput = discriminator(x)
gan = Model(inputs=ganInput, outputs=ganOutput)
gan.compile(loss='binary_crossentropy', optimizer=optimizer)
```

```
# To generate the images

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('image_generated_%d.png' % epoch)
```

```
# Training the model for 1 epochs

def train(epochs=1, batch_size=128):

  x_train, y_train, x_test, y_test = load_minst_data()
  batch_count = x_train.shape[0] / batch_size
  for e in range(1, epochs+1):
    print('-'*10, 'Epoch %d' % e, '-'*10)
    for _ in tqdm(range(int(batch_count))):

      noise = np.random.normal(0, 1, size=[batch_size, random_dim])
      generated_images = generator.predict(noise)
      image_batch = x_train[np.random.randint(0, x_train.shape[0], size=batch_size)]
      print("d")
      X = np.concatenate([image_batch, generated_images])
      y_dis = np.zeros(2*batch_size)
      y_dis[:batch_size] = 0.9
      discriminator.trainable = True
      discriminator.train_on_batch(X, y_dis)
      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)
```

```
    plot_generated_images(e, generator)

train(1,128)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz
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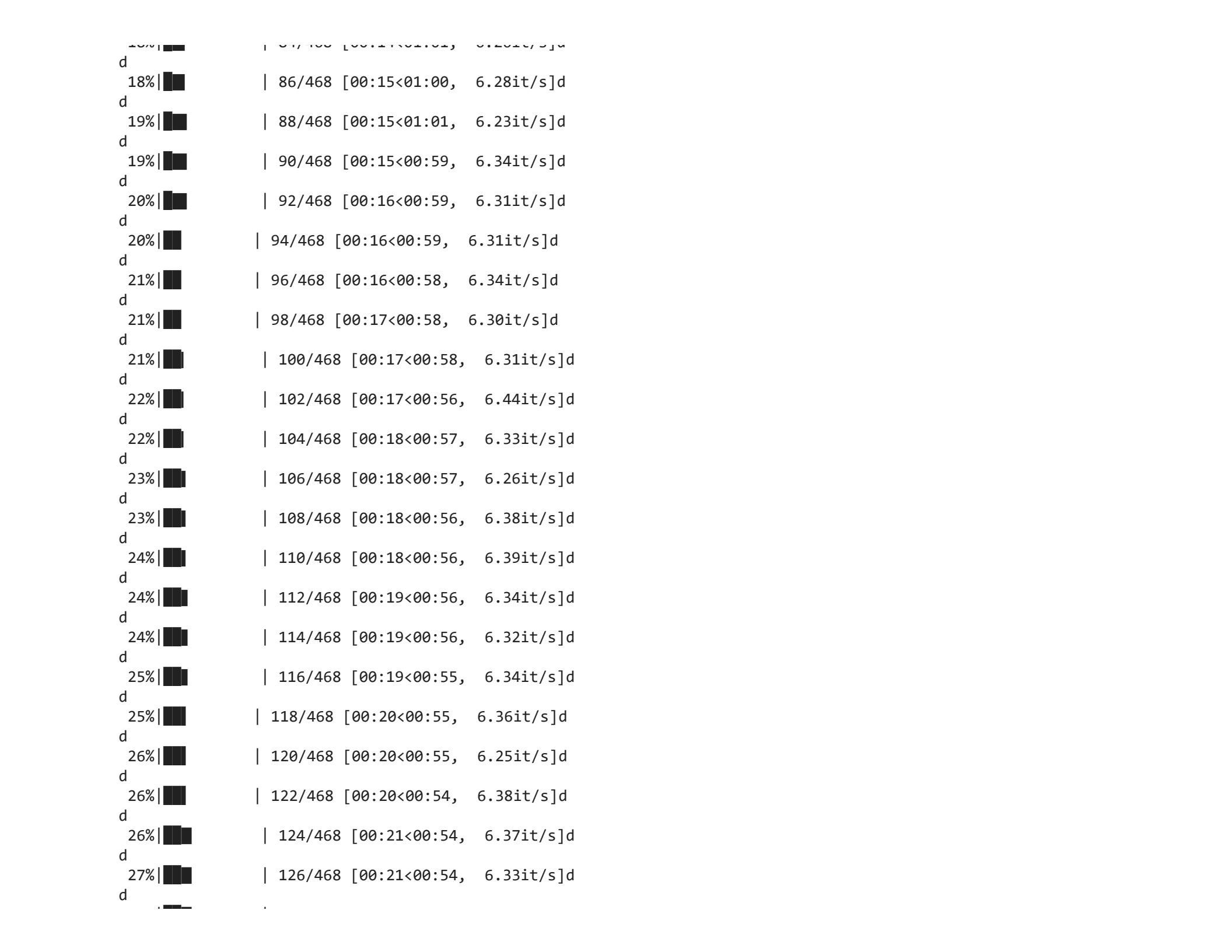
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 82%|████████▏ | 382/468 [01:02<00:13,  6.30it/s]d
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 82%|████████▏ | 384/468 [01:02<00:13,  6.30it/s]d
d
 82%|████████▏ | 386/468 [01:02<00:13,  6.23it/s]d
d
 83%|████████▎ | 388/468 [01:03<00:12,  6.28it/s]d
```

```
a
 83%|████████▎  | 390/468 [01:03<00:12,  6.34it/s]d
d
 84%|████████▍  | 392/468 [01:03<00:12,  6.23it/s]d
d
 84%|████████▍  | 394/468 [01:04<00:11,  6.21it/s]d
d
 85%|████████▍  | 396/468 [01:04<00:11,  6.26it/s]d
d
 85%|████████▌  | 398/468 [01:04<00:11,  6.25it/s]d
d
 85%|████████▌  | 400/468 [01:05<00:10,  6.30it/s]d
d
 86%|████████▌  | 402/468 [01:05<00:10,  6.34it/s]d
d
 86%|████████▌  | 404/468 [01:05<00:10,  6.27it/s]d
d
 87%|████████▋  | 406/468 [01:06<00:09,  6.26it/s]d
d
 87%|████████▋  | 408/468 [01:06<00:09,  6.37it/s]d
d
 88%|████████▊  | 410/468 [01:06<00:09,  6.38it/s]d
d
 88%|████████▊  | 412/468 [01:07<00:08,  6.26it/s]d
 88%|████████▊  | 413/468 [01:07<00:10,  5.00it/s]d
d
 89%|████████▊  | 415/468 [01:07<00:09,  5.62it/s]d
d
 89%|████████▉  | 417/468 [01:08<00:08,  5.94it/s]d
d
 90%|████████▉  | 419/468 [01:08<00:08,  6.08it/s]d
d
 90%|████████▉  | 421/468 [01:08<00:07,  6.19it/s]d
d
 90%|█████████  | 423/468 [01:09<00:07,  6.21it/s]d
d
 91%|█████████  | 425/468 [01:09<00:06,  6.30it/s]d
d
 91%|█████████  | 427/468 [01:09<00:06,  6.37it/s]d
d
 92%|█████████▏ | 429/468 [01:09<00:06,  6.36it/s]d
d
 92%|█████████▏ | 431/468 [01:10<00:05,  6.28it/s]d
d
```

```
 93%|█████████▎ | 433/468 [01:10<00:05,  6.38it/s]d
d
 93%|█████████▎ | 435/468 [01:10<00:05,  6.35it/s]d
d
 93%|█████████▎ | 437/468 [01:11<00:04,  6.34it/s]d
d
 94%|█████████▍ | 439/468 [01:11<00:04,  6.26it/s]d
d
 94%|█████████▍ | 441/468 [01:11<00:04,  6.39it/s]d
d
 95%|█████████▍ | 443/468 [01:12<00:03,  6.34it/s]d
d
 95%|█████████▌ | 445/468 [01:12<00:03,  6.38it/s]d
d
 96%|█████████▌ | 447/468 [01:12<00:03,  6.32it/s]d
d
 96%|█████████▌ | 449/468 [01:13<00:03,  6.32it/s]d
d
 96%|█████████▋ | 451/468 [01:13<00:02,  6.29it/s]d
d
 97%|█████████▋ | 453/468 [01:13<00:02,  6.32it/s]d
d
 97%|█████████▋ | 455/468 [01:14<00:02,  6.27it/s]d
d
 98%|█████████▊ | 457/468 [01:14<00:01,  6.33it/s]d
d
 98%|█████████▊ | 459/468 [01:14<00:01,  6.38it/s]d
d
 99%|█████████▊ | 461/468 [01:15<00:01,  6.39it/s]d
d
 99%|█████████▉ | 463/468 [01:15<00:00,  6.29it/s]d
d
 99%|█████████▉ | 465/468 [01:15<00:00,  6.21it/s]d
d
100%|█████████▉ | 467/468 [01:15<00:00,  6.31it/s]d
d
```

```
# Training the model for 30 epochs

def train(epochs=30, batch_size=128):

  x_train, y_train, x_test, y_test = load_minst_data()
  batch_count = x_train.shape[0] / batch_size
```

```
  for e in range(1, epochs+1):
    print('-'*10, 'Epoch %d' % e, '-'*10)
    for _ in tqdm(range(int(batch_count))):

      noise = np.random.normal(0, 1, size=[batch_size, random_dim])
      generated_images = generator.predict(noise)
      image_batch = x_train[np.random.randint(0, x_train.shape[0], size=batch_size)]
      X = np.concatenate([image_batch, generated_images])
      y_dis = np.zeros(2*batch_size)
      y_dis[:batch_size] = 0.9
      discriminator.trainable = True
      discriminator.train_on_batch(X, y_dis)
      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)

    plot_generated_images(e, generator)

train(1,128)
```

```
  0%|          | 1/468 [00:00<01:17,  6.00it/s]---------- Epoch 1 ----------
100%|██████████| 468/468 [01:14<00:00,  6.27it/s]
```