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PYTHON PROGRAM TO BUILD GAN WITH KERAS

Aim:

To build GAN (Generative Adversarial Network) with keras in python.

Procedure:

1. Import necessary libraries including NumPy, Matplotlib, TensorFlow Keras components, and MNIST dataset.
2. Load and preprocess the MNIST dataset, normalizing images and reshaping them to (batch_size, 28, 28, 1).
3. Define image dimensions and random noise vector dimension for the GAN.
4. Build the Generator model with Dense layers, LeakyReLU activations, BatchNormalization, and a final output reshaped to the image dimensions.
5. Build the Discriminator model with Flatten, Dense layers, LeakyReLU activations, and a final sigmoid activation.
6. Build the GAN model by combining the Generator and Discriminator models, setting the Discriminator layers to non-trainable.
7. Compile the Discriminator and GAN models using Adam optimizer and binary cross-entropy loss.
8. Implement the training function to alternately train the Discriminator on real and fake images, then train the Generator.
9. Save generated images at specified intervals during training to visualize the Generator's progress.
10. Execute the training process for a defined number of epochs, saving generated images every save_interval epochs.

Code:

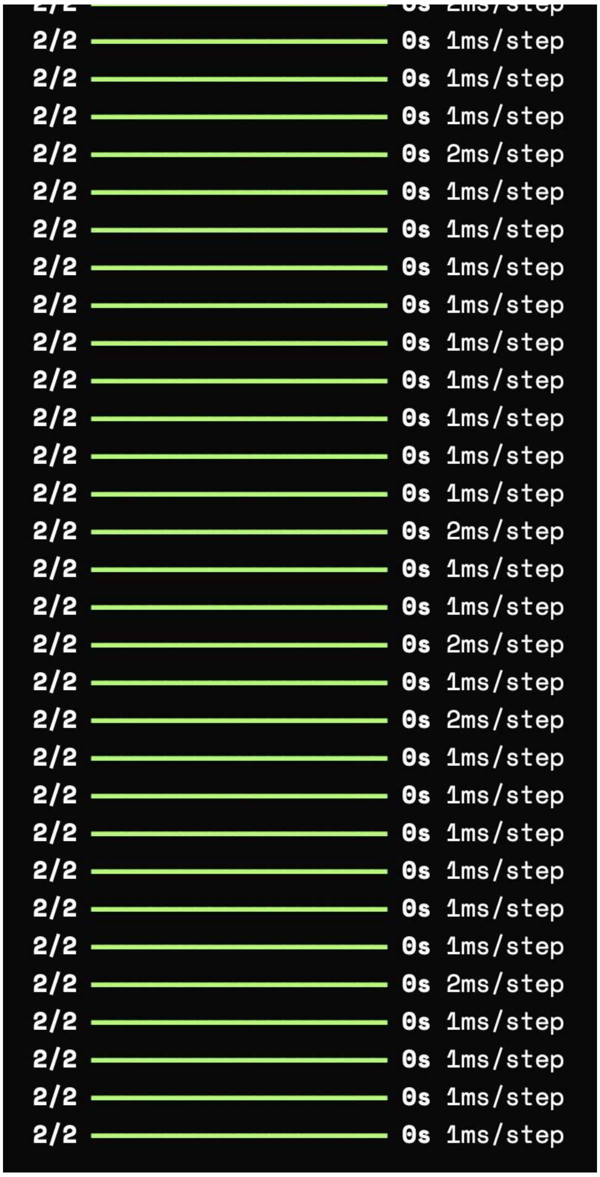
```
# Import necessary libraries import numpy as np import
matplotlib.pyplot as plt from tensorflow.keras.datasets import
mnist from tensorflow.keras.models import Sequential, Model
from tensorflow.keras.layers import Dense, LeakyReLU, BatchNormalization, Reshape,
Flatten
from tensorflow.keras.optimizers import Adam

# Load and preprocess the MNIST dataset
(X_train, _), (_, _) = mnist.load_data()
X_train = X_train / 255.0 # Normalize images to [0, 1]
X_train = X_train.reshape(X_train.shape[0], 28, 28, 1) # Reshape to (batch_size,
28, 28, 1)

# Define the dimensions
img_rows, img_cols, channels = 28, 28, 1 img_shape =
(img_rows, img_cols, channels) z_dim = 100 # Dimension
of the random noise vector

# Build the Generator model def
build_generator():    model    =
Sequential()
   model.add(Dense(256, input_dim=z_dim))
   model.add(LeakyReLU(alpha=0.2))
   model.add(BatchNormalization())
   model.add(Dense(512))
   model.add(LeakyReLU(alpha=0.2))
   model.add(BatchNormalization())
   model.add(Dense(1024))
   model.add(LeakyReLU(alpha=0.2))
   model.add(BatchNormalization())
   model.add(Dense(np.prod(img_shape),         activation='tanh'))
   model.add(Reshape(img_shape)) return model
```

```
# Build the Discriminator model def
build_discriminator(): model =
Sequential()
  model.add(Flatten(input_shape=img_shape))
  model.add(Dense(512))
  model.add(LeakyReLU(alpha=0.2))
  model.add(Dense(256))
  model.add(LeakyReLU(alpha=0.2))
  model.add(Dense(1, activation='sigmoid')) return
  model

# Build the GAN model def
build_gan(generator, discriminator):
  discriminator.trainable = False
  model = Sequential()
  model.add(generator)
  model.add(discriminator) return
  model

# Compile the models def compile_models(generator,
discriminator, gan):
  discriminator.compile(optimizer=Adam(), loss='binary_crossentropy',
metrics=['accuracy'])
  gan.compile(optimizer=Adam(), loss='binary_crossentropy')
# Training function def train_gan(epochs, batch_size=128,
save_interval=50): # Load the discriminator and generator
models generator = build_generator() discriminator =
build_discriminator() gan = build_gan(generator,
discriminator) compile_models(generator, discriminator, gan)

  # Training loop for epoch in
  range(epochs): # Train the
  Discriminator
```

```
    idx  =  np.random.randint(0,  X_train.shape[0],  batch_size)
    real_imgs = X_train[idx] real_labels = np.ones((batch_size, 1))
    fake_imgs = generator.predict(np.random.randn(batch_size, z_dim)) fake_labels =
    np.zeros((batch_size, 1))

    d_loss_real = discriminator.train_on_batch(real_imgs, real_labels) d_loss_fake =
    discriminator.train_on_batch(fake_imgs, fake_labels) d_loss = 0.5 *
    np.add(d_loss_real, d_loss_fake)

    # Train the Generator
    noise = np.random.randn(batch_size, z_dim) valid_labels =
    np.ones((batch_size, 1))
    g_loss = gan.train_on_batch(noise, valid_labels)

    # Print progress and save generated images if epoch
    % save_interval == 0:
          print(f"{epoch} [D loss: {d_loss[0]} | D accuracy: {100 * d_loss[1]]}%] [G
loss:   {g_loss}]")   save_generated_images(generator,
      epoch)


# Function to save generated images
def save_generated_images(generator, epoch, examples=16, dim=(4, 4), figsize=(4, 4)):
  noise = np.random.randn(examples, z_dim) gen_imgs =
  generator.predict(noise)
  gen_imgs = 0.5 * gen_imgs + 0.5 # Rescale images to [0, 1]
  plt.figure(figsize=figsize) for i in range(examples):
    plt.subplot(dim[0],    dim[1],    i    +    1)
    plt.imshow(gen_imgs[i,  :,  :,  0],  cmap='gray')
    plt.axis('off')
  plt.tight_layout()
  plt.savefig(f"gan_generated_images_epoch_{epoch}.png") plt.close()

# Run the training
```

```
train_gan(epochs=10000, batch_size=64, save_interval=1000)
```

Output:



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Result:

Thus, to build GAN with keras with python has been completed successfully.