```
import os
import sys
from tempfile import NamedTemporaryFile
from urllib.request import urlopen
from urllib.parse import unquote, urlparse
from urllib.error import HTTPError
from zipfile import ZipFile
import tarfile
import shutil

CHUNK_SIZE = 40960
DATA_SOURCE_MAPPING = 'horse2zebra-dataset:https%3A%2F%2Fstorage.googleapis.com%2Fkaggle-data-sets%2F926321%2F1567596%2Fbundle%2Farchive.zip

KAGGLE_INPUT_PATH='/kaggle/input'
KAGGLE_WORKING_PATH='/kaggle/working'
KAGGLE_SYMLINK='kaggle'

!umount /kaggle/input/ 2> /dev/null
shutil.rmtree('/kaggle/input', ignore_errors=True)
os.makedirs(KAGGLE_INPUT_PATH, 0o777, exist_ok=True)
os.makedirs(KAGGLE_WORKING_PATH, 0o777, exist_ok=True)

try:
  os.symlink(KAGGLE_INPUT_PATH, os.path.join("..", 'input'), target_is_directory=True)
except FileExistsError:
  pass
try:
  os.symlink(KAGGLE_WORKING_PATH, os.path.join("..", 'working'), target_is_directory=True)
except FileExistsError:
  pass

for data_source_mapping in DATA_SOURCE_MAPPING.split(','):
    directory, download_url_encoded = data_source_mapping.split(':')
    download_url = unquote(download_url_encoded)
    filename = urlparse(download_url).path
    destination_path = os.path.join(KAGGLE_INPUT_PATH, directory)
    try:
        with urlopen(download_url) as fileres, NamedTemporaryFile() as tfile:
            total_length = fileres.headers['content-length']
            print(f'Downloading {directory}, {total_length} bytes compressed')
            dl = 0
            data = fileres.read(CHUNK_SIZE)
            while len(data) > 0:
                dl += len(data)
                tfile.write(data)
                done = int(50 * dl / int(total_length))
                sys.stdout.write(f"\r[{'=' * done}{' ' * (50-done)}] {dl} bytes downloaded")
                sys.stdout.flush()
                data = fileres.read(CHUNK_SIZE)
            if filename.endswith('.zip'):
              with ZipFile(tfile) as zfile:
                zfile.extractall(destination_path)
            else:
              with tarfile.open(tfile.name) as tarfile:
                tarfile.extractall(destination_path)
            print(f'\nDownloaded and uncompressed: {directory}')
    except HTTPError as e:
        print(f'Failed to load (likely expired) {download_url} to path {destination_path}')
        continue
    except OSError as e:
        print(f'Failed to load {download_url} to path {destination_path}')
        continue

print('Data source import complete.')
```

```
Downloading horse2zebra-dataset, 116809009 bytes compressed
[==================================================] 116809009 bytes downloaded
Downloaded and uncompressed: horse2zebra-dataset
Downloading imagetoimage-translation-cyclegan, 523920850 bytes compressed
[==================================================] 523920850 bytes downloaded
Downloaded and uncompressed: imagetoimage-translation-cyclegan
Data source import complete.
```

```
from IPython.display import clear_output as clear
!pip install tensorflow-addons
clear()
```

```
# Common
import os
import keras
import numpy as np
from glob import glob
from tqdm import tqdm
import tensorflow as tf
from random import random

# Data
import tensorflow.image as tfi
import matplotlib.pyplot as plt
from keras.preprocessing.image import load_img
from keras.preprocessing.image import img_to_array

# Model Layers
from keras.layers import ReLU
from keras.layers import Input
from keras.layers import Conv2D
from keras.layers import Dropout
from keras.layers import LeakyReLU
from keras.layers import Activation
from keras.layers import concatenate
from keras.layers import ZeroPadding2D
from keras.layers import Conv2DTranspose
from tensorflow_addons.layers import InstanceNormalization

# Model Functions
from keras.models import Model
from keras.models import load_model
from keras.models import Sequential
from keras.initializers import RandomNormal

# Optimizers
from tensorflow.keras.optimizers import Adam

# Loss
from keras.losses import BinaryCrossentropy

# Model Viz
from tensorflow.keras.utils import plot_model
```

```
/usr/local/lib/python3.10/dist-packages/tensorflow_addons/utils/tfa_eol_msg.py:23: UserWarning:

TensorFlow Addons (TFA) has ended development and introduction of new features.
TFA has entered a minimal maintenance and release mode until a planned end of life in May 2024.
Please modify downstream libraries to take dependencies from other repositories in our TensorFlow community (e.g. Keras, Keras-CV, and K

For more information see: https://github.com/tensorflow/addons/issues/2807

  warnings.warn(
```

```
def show_image(image, title=None):
    '''
    The function takes in an image and plots it using Matplotlib.
    '''
    plt.imshow(image)
    plt.title(title)
    plt.axis('off')
```

```
root_horse_path = '../input/horse2zebra-dataset/trainA'
root_zebra_path = '../input/horse2zebra-dataset/trainB'
horse_paths = sorted(glob(root_horse_path + '/*.jpg'))[:1000]
zebra_paths = sorted(glob(root_zebra_path + '/*.jpg'))[:1000]
```

```
SIZE = 256
horse_images, zebra_images = np.zeros(shape=(len(horse_paths),SIZE,SIZE,3)), np.zeros(shape=(len(horse_paths),SIZE,SIZE,3))
for i,(horse_path, zebra_path) in tqdm(enumerate(zip(horse_paths, zebra_paths)), desc='Loading'):

    horse_image = img_to_array(load_img(horse_path))
    horse_image = tfi.resize(tf.cast(horse_image, tf.float32)/255., (SIZE, SIZE))

    zebra_image = img_to_array(load_img(zebra_path))
    zebra_image = tfi.resize(tf.cast(zebra_image,tf.float32)/255., (SIZE, SIZE))

    # as the data is unpaired so we don't have to worry about, positioning the images.

    horse_images[i] = horse_image
    zebra_images[i] = zebra_image
```

```
Loading: 1000it [00:16, 59.64it/s]
```

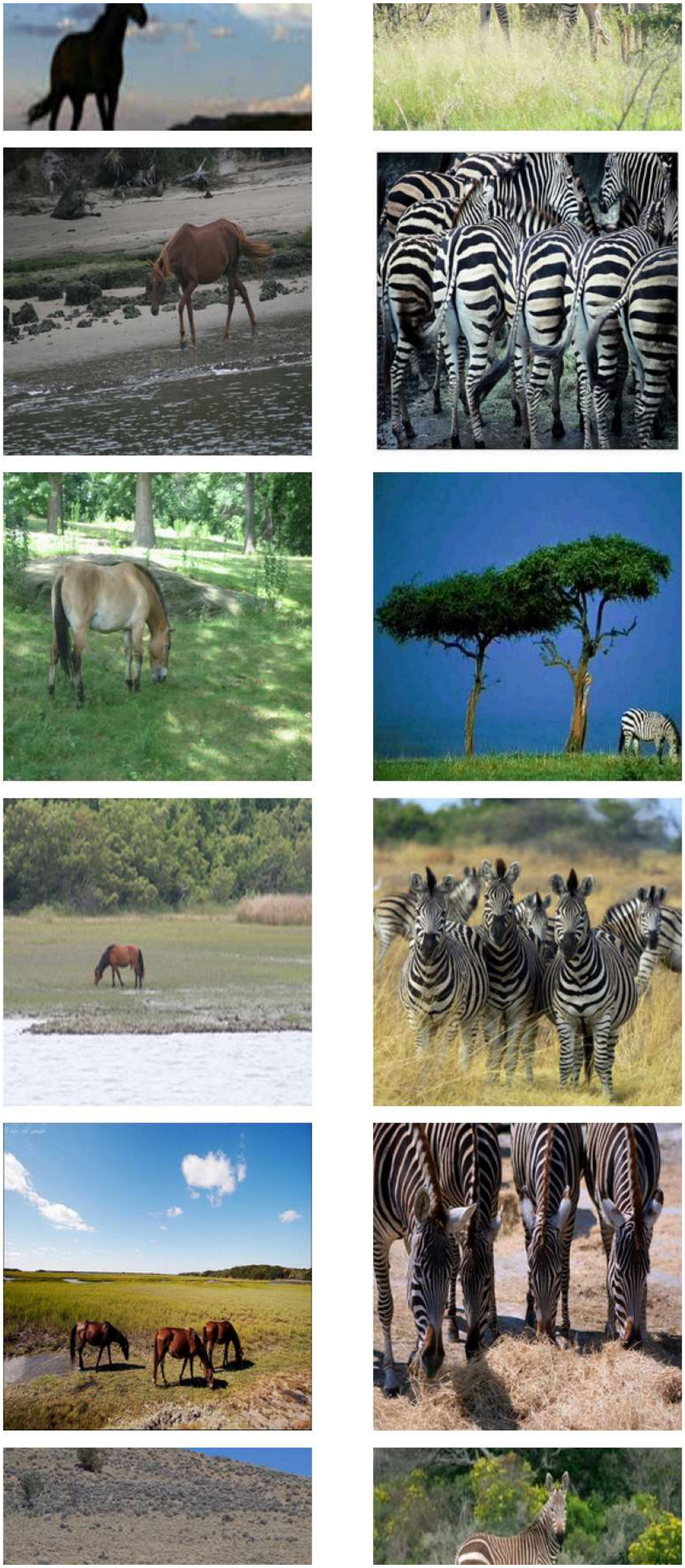
```
dataset = [horse_images, zebra_images]
```

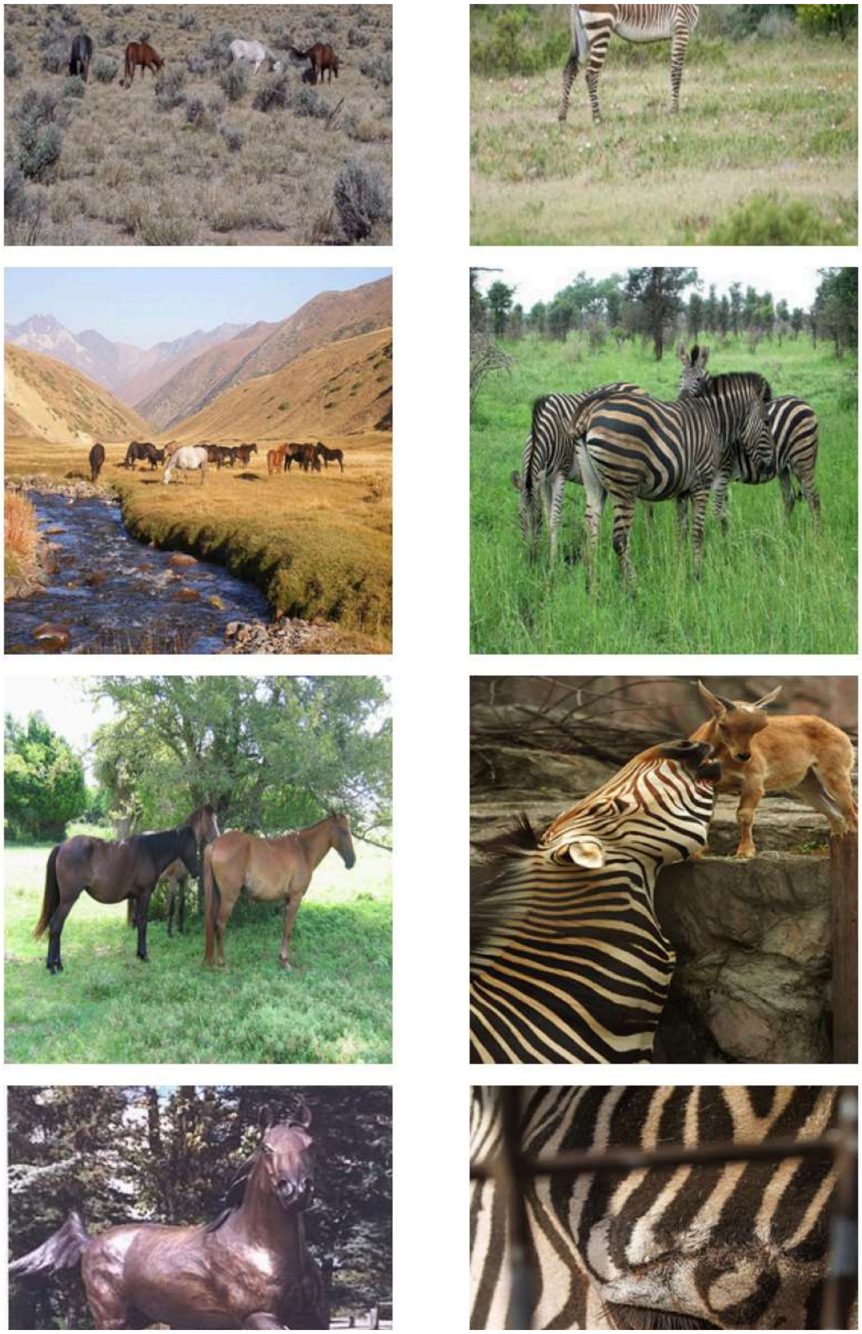
```
# Visualizing
for i in range(10):
    id = np.random.randint(len(horse_images))
    horse, zebra = horse_images[id], zebra_images[id]

    plt.figure(figsize=(10,8))

    plt.subplot(1,2,1)
    show_image(horse)

    plt.subplot(1,2,2)
    show_image(zebra)
    plt.show()
```





```
def ResidualBlock(filters, layer, index):
#     init = RandomNormal(stddev=0.02)

    x = Conv2D(filters, kernel_size=3, strides=1, padding='same', kernel_initializer='he_normal', use_bias=False, name="Block_{}_Conv1".form
    x = InstanceNormalization(axis=-1, name="Block_{}_Normalization1".format(index))(x)
    x = ReLU(name="Block_{}_ReLU".format(index))(x)

    x = Conv2D(filters, kernel_size=3, strides=1, padding='same', kernel_initializer='he_normal', use_bias=False, name="Block_{}_Conv2".form
    x = InstanceNormalization(axis=-1, name="Block_{}_Normalization2".format(index))(x)

    x = concatenate([x, layer], name="Block_{}_Merge".format(index))

    return x


def downsample(filters, layer, size=3, strides=2, activation=None, index=None, norm=True):
    x = Conv2D(filters, kernel_size=size, strides=strides, padding='same', kernel_initializer='he_normal', use_bias=False, name="Encoder_{}_C
    if norm:
        x = InstanceNormalization(axis=-1, name="Encoder_{}_Normalization".format(index))(x)
    if activation is not None:
        x = Activation(activation, name="Encoder_{}_Activation".format(index))(x)
    else:
        x = LeakyReLU( name="Encoder_{}_LeakyReLU".format(index))(x)
    return x


def upsample(filters, layer, size=3, strides=2, index=None):
    x = Conv2DTranspose(filters, kernel_size=size, strides=strides, padding='same', kernel_initializer='he_normal', use_bias=False, name="De
    x = InstanceNormalization(axis=-1, name="Decoder_{}_Normalization".format(index))(x)
    x = ReLU( name="Encoder_{}_ReLU".format(index))(x)
    return x
```

```
def Generator(n_resnet=9, name="Generator"):

    inp_image = Input(shape=(SIZE, SIZE, 3), name="InputImage")         # 256 x 256 x3

    x = downsample(64, inp_image, size=7, strides=1, index=1)           # 256 x 256 x 64
    x = downsample(128, x, index=2)                                     # 128 x 128 x 128
    x = downsample(256, x, index=3)                                     # 64 x 64 x 256

    for i in range(n_resnet):
        x = ResidualBlock(256, x, index=i+4)                             # (64 x 64 x 256) x n_resnet

    x = upsample(128, x, index=13)                                       # 128 x 128 x 128
    x = upsample(64, x, index=14)                                        # 256 x 256 x 64
    x = downsample(3, x, size=7, strides=1, activation='tanh', index=15) # 256 x 256 x 3

    model = Model(
        inputs=inp_image,
        outputs=x,
        name=name
    )
    return model


def Discriminator(name='Discriminator'):
    init = RandomNormal(stddev=0.02)
    src_img = Input(shape=(SIZE, SIZE, 3), name="InputImage")     # 256 x 256 x 3
    x = downsample(64, src_img, size=4, strides=2, index=1, norm=False) # 128 x 128 x 64
    x = downsample(128, x, size=4, strides=2, index=2)            # 64 x 64 x 128
    x = downsample(256, x, size=4, strides=2, index=3)            # 32 x 32 x 256
    x = downsample(512, x, size=4, strides=2, index=4)            # 16 x 16 x 512
    x = downsample(512, x, size=4, strides=2, index=5)            # 8 x 8 x 512  # we can try out a different architecture with zero padding
    patch_out = Conv2D(1, kernel_size=4, padding='same', kernel_initializer=init, use_bias=False)(x) # 8 x 8 x 1

    model = Model(
        inputs=src_img,
        outputs=patch_out,
        name=name
    )
    model.compile(
        loss='mse',
        optimizer=Adam(learning_rate=2e-4, beta_1=0.5),
        loss_weights=[0.5]
    )
    return model
```

```
def CombineModel(g_model1, g_model2, d_model, name):
    # train the Generator
    g_model1.trainable = True

    # Stop the Discriminator and 2nd Generator
    d_model.trainable = False
    g_model2.trainable = False

    # Adversarial Loss
    input_gen = Input(shape=(SIZE, SIZE, 3))
    gen_1_out = g_model1(input_gen)
    dis_out = d_model(gen_1_out)

    # Identity Loss
    input_id = Input(shape=(SIZE, SIZE, 3))
    output_id = g_model1(input_id)

    # Cycle Loss - Forward
    output_f = g_model2(gen_1_out)

    # Cycle Loss - Backward
    gen_2_out = g_model2(input_id)
    output_b = g_model1(gen_2_out)

    # Final Model
    model = Model(
        inputs=[input_gen, input_id],
        outputs=[dis_out, output_id, output_f, output_b],
        name=name
    )
    model.compile(
        loss=['mse', 'mae', 'mae', 'mae'],
        loss_weights=[1,5,10,10],
        optimizer= Adam(learning_rate=2e-4, beta_1=0.5)
    )
    return model


def generate_real_samples(n_samples, dataset):
    ix = np.random.randint(0,dataset.shape[0], n_samples)
    X = dataset[ix]
    y = np.ones(shape=(n_samples, 8, 8, 1))
    return X, y


def generate_fake_samples(g_model, dataset):
    X = g_model.predict(dataset)
    y = np.zeros(shape=(len(dataset), 8, 8, 1))
    return X, y


def update_image_pool(pool, images, max_size=50):
    selected = list()
    for image in images:
        if len(pool) < max_size:
            pool.append(image)
            selected.append(image)
        elif random() < 0.5:
            selected.append(image)
        else:
            ix = np.random.randint(0,len(pool))
            selected.append(pool[ix])
            pool[ix] = image
    return np.asarray(selected)
```

```
def show_preds(g_AB, g_BA,n_images=1):
    for i in range(n_images):

        id = np.random.randint(len(horse_images))
        horse, zebra = horse_images[id], zebra_images[id]
        horse_pred, zebra_pred = g_BA.predict(tf.expand_dims(zebra,axis=0))[0], g_AB.predict(tf.expand_dims(horse,axis=0))[0]

        plt.figure(figsize=(10,8))

        plt.subplot(1,4,1)
        show_image(horse, title='Original Horse')

        plt.subplot(1,4,2)
        show_image(zebra_pred, title='Generated Zebra')

        plt.subplot(1,4,3)
        show_image(zebra, title='Original Zebra')

        plt.subplot(1,4,4)
        show_image(horse_pred, title='Genrated Horse')

        plt.tight_layout()
        plt.show()


def train(d_model_A, d_model_B, gen_AB, gen_BA, c_AB, c_BA, epochs=10, chunk=5):

    n_epochs, n_batch = epochs, 1

    trainA, trainB = dataset
    poolA, poolB = list(), list()

    # in simple words, we are going through the whole data.
    bat_per_epoch = int(len(trainA)/n_batch)
    n_steps = bat_per_epoch

    for j in tqdm(range(1,epochs+1), desc="Epochs"):
        for i in range(n_steps):

            # Let's get some real data in hand.
            X_realA, y_realA = generate_real_samples(n_batch, trainA)
            X_realB, y_realB = generate_real_samples(n_batch, trainB)

            # use our generators to generate some fake data.
            X_fakeA, y_fakeA = generate_fake_samples(gen_BA, X_realB)
            X_fakeB, y_fakeB = generate_fake_samples(gen_AB, X_realA)

            # create a pool of images. You can also understand it like a replay buffer.
            X_fakeA = update_image_pool(poolA, X_fakeA)
            X_fakeB = update_image_pool(poolA, X_fakeB)


            # Let's finally train the gen 2 and get the losses.
            gen_loss2, _, _, _, _ = c_BA.train_on_batch(
                [X_realB, X_realA],
                [y_realB, X_realA, X_realB, X_realA]
            )

            # It's time for our discriminator to win our generator.
            dA_loss_1 = d_model_A.train_on_batch(X_realA, y_realA)
            dA_loss_2 = d_model_A.train_on_batch(X_fakeA, y_fakeA)

            # one cycle is completed, let's move to second cycle.
            gen_loss1, _, _, _, _ = c_AB.train_on_batch(
                [X_realA, X_realB],
                [y_realA, X_realB, X_realA, X_realB]
            )

            # again, let's give some power to our discriminators.
            dB_loss_1 = d_model_B.train_on_batch(X_realB, y_realB)
            dB_loss_2 = d_model_B.train_on_batch(X_fakeB, y_fakeB)

        if (j%chunk)==0:
            show_preds(gen_AB, gen_BA, n_images=1)
            gen_AB.save("GeneratorHtoZ.h5")
            gen_BA.save("GeneratorZtoH.h5")
```

```
# let's create our generators.
g_AB = Generator(name="GeneratorAB")
g_BA = Generator(name="GeneratorBA")

# here are the respective discriminators.
d_A = Discriminator(name="DiscriminatorA")
d_B = Discriminator(name="DiscriminatorB")

# finally, let's combine all of them.
c_AB = CombineModel(g_AB, g_BA, d_B, name="GanAB")
c_BA = CombineModel(g_BA, g_AB, d_A, name="GanBA")
```

```
# # it's time to give them the superior knowledge.
# train(d_A, d_B, g_AB, g_BA, c_AB, c_BA, epochs=100, chunk=5)
```

```
# g_AB.save("GeneratorHtoZ.h5")
# g_BA.save("GeneratorZtoH.h5")
```

```
HtoZ_gen = load_model("../input/imagetoimage-translation-cyclegan/GeneratorHtoZ.h5")
ZtoH_gen = load_model("../input/imagetoimage-translation-cyclegan/GeneratorZtoH.h5")
```

```
     WARNING:root:The given value for groups will be overwritten.
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     WARNING:tensorflow:No training configuration found in the save file, so the model was *not* compiled. Compile it manually.
     WARNING:root:The given value for groups will be overwritten.
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     WARNING:root:The given value for groups will be overwritten.
     WARNING:root:The given value for groups will be overwritten.
     WARNING:tensorflow:No training configuration found in the save file, so the model was *not* compiled. Compile it manually.
```
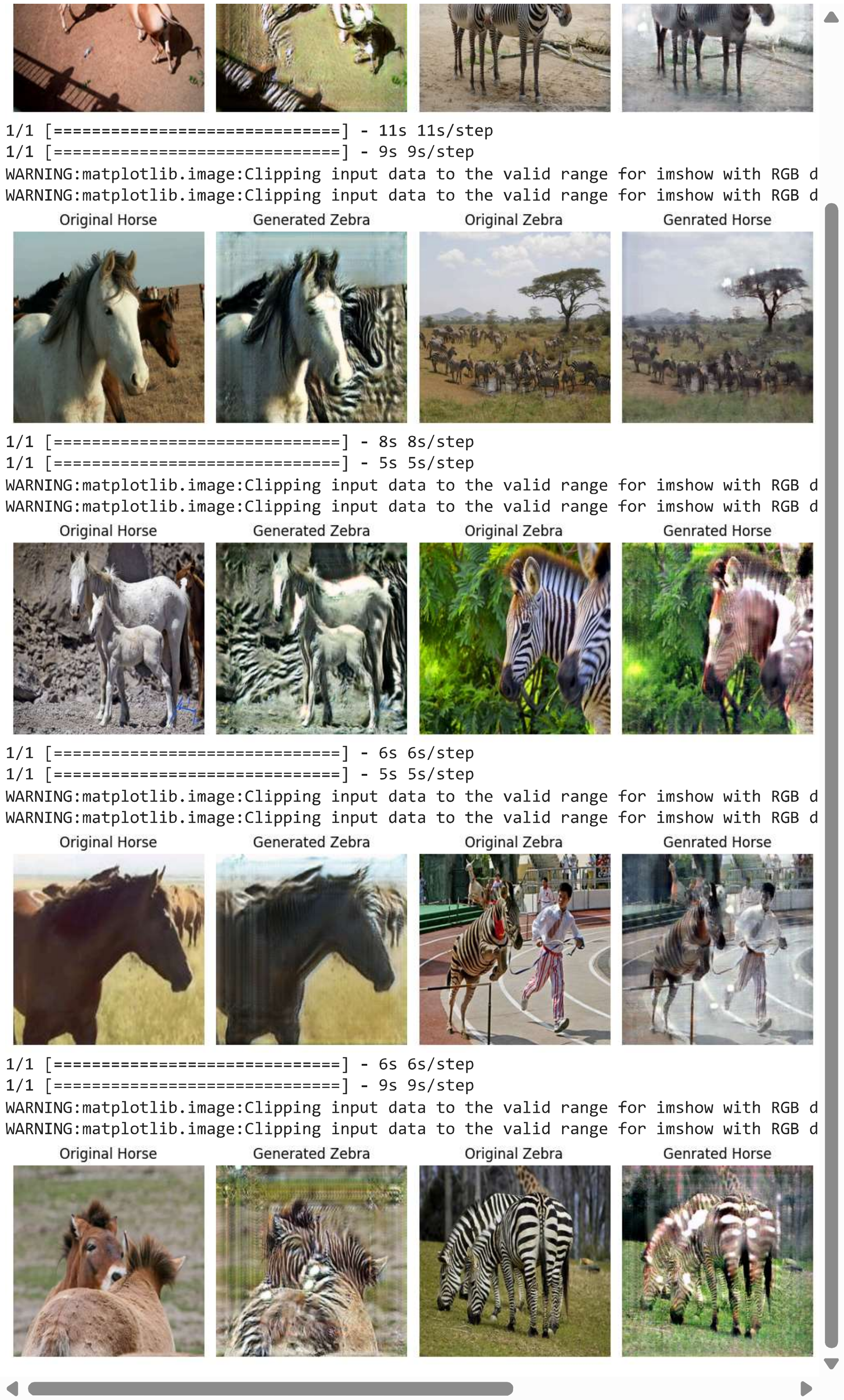

```
show_preds(HtoZ_gen, ZtoH_gen, n_images=5)
```



```
1/1 [==============================] - 11s 11s/step
1/1 [==============================] - 9s 9s/step
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
```

```
1/1 [==============================] - 8s 8s/step
1/1 [==============================] - 5s 5s/step
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
```

```
1/1 [==============================] - 6s 6s/step
1/1 [==============================] - 5s 5s/step
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
```

```
1/1 [==============================] - 6s 6s/step
1/1 [==============================] - 9s 9s/step
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB d
```