stylegan

April 1, 2024

0.1 Setup

[ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

[ ]:
```
!pip install tensorflow_addons
```

```
Collecting tensorflow_addons
  Downloading tensorflow_addons-0.23.0-cp310-cp310-manylinux_2_17_x86_64.manylin
ux2014_x86_64.whl (611 kB)
                           611.8/611.8
kB 3.5 MB/s eta 0:00:00
Requirement already satisfied: packaging in
/usr/local/lib/python3.10/dist-packages (from tensorflow_addons) (24.0)
Collecting typeguard<3.0.0,>=2.7 (from tensorflow_addons)
  Downloading typeguard-2.13.3-py3-none-any.whl (17 kB)
Installing collected packages: typeguard, tensorflow_addons
Successfully installed tensorflow_addons-0.23.0 typeguard-2.13.3
```

[ ]:
```
import os
import numpy as np
import matplotlib.pyplot as plt

from functools import partial

import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
from tensorflow.keras.models import Sequential
from tensorflow_addons.layers import InstanceNormalization

import gdown
from zipfile import ZipFile
```

```
/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 Keras-NLP).

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

  warnings.warn(
```

[ ]:
```python
def log2(x):
    return int(np.log2(x))


# we use different batch size for different resolution, so larger image size
# could fit into GPU memory. The keys is image resolution in log2
batch_sizes = {2: 16, 3: 16, 4: 16, 5: 16, 6: 16, 7: 8, 8: 4, 9: 2, 10: 1}
# We adjust the train step accordingly
train_step_ratio = {k: batch_sizes[2] / v for k, v in batch_sizes.items()}


os.makedirs("celeba_gan")

url = "https://drive.google.com/uc?id=1O7m1010EJjLE5QxLZiM9Fpjs7Oj6e684"
output = "celeba_gan/data.zip"
gdown.download(url, output, quiet=True)

with ZipFile("celeba_gan/data.zip", "r") as zipobj:
    zipobj.extractall("celeba_gan")

# Create a dataset from our folder, and rescale the images to the [0-1] range:

ds_train = keras.utils.image_dataset_from_directory(
    "celeba_gan", label_mode=None, image_size=(64, 64), batch_size=32
)



def resize_image(res, image):
    # only downsampling, so use nearest neighbor that is faster to run
    image = tf.image.resize(
        image, (res, res), method=tf.image.ResizeMethod.NEAREST_NEIGHBOR
    )
    image = tf.cast(image, tf.float32) / 127.5 - 1.0
    return image
```

```
def create_dataloader(res):
    batch_size = batch_sizes[log2(res)]
    dl = ds_train.map(partial(resize_image, res), num_parallel_calls=tf.data.
 ↪AUTOTUNE).unbatch()
    dl = dl.shuffle(200).batch(batch_size, drop_remainder=True).prefetch(1).
 ↪repeat()
    return dl
```

```
Found 202599 files belonging to 1 classes.
```

[ ]:
```
def plot_images(images, log2_res, fname=""):
    scales = {2: 0.5, 3: 1, 4: 2, 5: 3, 6: 4, 7: 5, 8: 6, 9: 7, 10: 8}
    scale = scales[log2_res]

    grid_col = min(images.shape[0], int(32 // scale))
    grid_row = 1

    f, axarr = plt.subplots(
        grid_row, grid_col, figsize=(grid_col * scale, grid_row * scale)
    )

    for row in range(grid_row):
        ax = axarr if grid_row == 1 else axarr[row]
        for col in range(grid_col):
            ax[col].imshow(images[row * grid_col + col])
            ax[col].axis("off")
    plt.show()
    if fname:
        f.savefig(fname)
```

[ ]:
```
def fade_in(alpha, a, b):
    return alpha * a + (1.0 - alpha) * b


def wasserstein_loss(y_true, y_pred):
    return -tf.reduce_mean(y_true * y_pred)


def pixel_norm(x, epsilon=1e-8):
    return x / tf.math.sqrt(tf.reduce_mean(x ** 2, axis=-1, keepdims=True) +␣
 ↪epsilon)


def minibatch_std(input_tensor, epsilon=1e-8):
    n, h, w, c = tf.shape(input_tensor)
    group_size = tf.minimum(4, n)
```

```
    x = tf.reshape(input_tensor, [group_size, -1, h, w, c])
    group_mean, group_var = tf.nn.moments(x, axes=(0), keepdims=False)
    group_std = tf.sqrt(group_var + epsilon)
    avg_std = tf.reduce_mean(group_std, axis=[1, 2, 3], keepdims=True)
    x = tf.tile(avg_std, [group_size, h, w, 1])
    return tf.concat([input_tensor, x], axis=-1)


class EqualizedConv(layers.Layer):
    def __init__(self, out_channels, kernel=3, gain=2, **kwargs):
        super().__init__(**kwargs)
        self.kernel = kernel
        self.out_channels = out_channels
        self.gain = gain
        self.pad = kernel != 1

    def build(self, input_shape):
        self.in_channels = input_shape[-1]
        initializer = keras.initializers.RandomNormal(mean=0.0, stddev=1.0)
        self.w = self.add_weight(
            shape=[self.kernel, self.kernel, self.in_channels, self.
 ↪out_channels],
            initializer=initializer,
            trainable=True,
            name="kernel",
        )
        self.b = self.add_weight(
            shape=(self.out_channels,), initializer="zeros", trainable=True,␣
 ↪name="bias"
        )
        fan_in = self.kernel * self.kernel * self.in_channels
        self.scale = tf.sqrt(self.gain / fan_in)

    def call(self, inputs):
        if self.pad:
            x = tf.pad(inputs, [[0, 0], [1, 1], [1, 1], [0, 0]], mode="REFLECT")
        else:
            x = inputs
        output = (
            tf.nn.conv2d(x, self.scale * self.w, strides=1, padding="VALID") +␣
 ↪self.b
        )
        return output


class EqualizedDense(layers.Layer):
    def __init__(self, units, gain=2, learning_rate_multiplier=1, **kwargs):
```

```
        super().__init__(**kwargs)
        self.units = units
        self.gain = gain
        self.learning_rate_multiplier = learning_rate_multiplier

    def build(self, input_shape):
        self.in_channels = input_shape[-1]
        initializer = keras.initializers.RandomNormal(
            mean=0.0, stddev=1.0 / self.learning_rate_multiplier
        )
        self.w = self.add_weight(
            shape=[self.in_channels, self.units],
            initializer=initializer,
            trainable=True,
            name="kernel",
        )
        self.b = self.add_weight(
            shape=(self.units,), initializer="zeros", trainable=True,␣
 ↪name="bias"
        )
        fan_in = self.in_channels
        self.scale = tf.sqrt(self.gain / fan_in)

    def call(self, inputs):
        output = tf.add(tf.matmul(inputs, self.scale * self.w), self.b)
        return output * self.learning_rate_multiplier


class AddNoise(layers.Layer):
    def build(self, input_shape):
        n, h, w, c = input_shape[0]
        initializer = keras.initializers.RandomNormal(mean=0.0, stddev=1.0)
        self.b = self.add_weight(
            shape=[1, 1, 1, c], initializer=initializer, trainable=True,␣
 ↪name="kernel"
        )

    def call(self, inputs):
        x, noise = inputs
        output = x + self.b * noise
        return output


class AdaIN(layers.Layer):
    def __init__(self, gain=1, **kwargs):
        super().__init__(**kwargs)
        self.gain = gain
```

```
    def build(self, input_shapes):
        x_shape = input_shapes[0]
        w_shape = input_shapes[1]

        self.w_channels = w_shape[-1]
        self.x_channels = x_shape[-1]

        self.dense_1 = EqualizedDense(self.x_channels, gain=1)
        self.dense_2 = EqualizedDense(self.x_channels, gain=1)

    def call(self, inputs):
        x, w = inputs
        ys = tf.reshape(self.dense_1(w), (-1, 1, 1, self.x_channels))
        yb = tf.reshape(self.dense_2(w), (-1, 1, 1, self.x_channels))
        return ys * x + yb
```

[ ]:
```
def Mapping(num_stages, input_shape=512):
    z = layers.Input(shape=(input_shape))
    w = pixel_norm(z)
    for i in range(8):
        w = EqualizedDense(512, learning_rate_multiplier=0.01)(w)
        w = layers.LeakyReLU(0.2)(w)
    w = tf.tile(tf.expand_dims(w, 1), (1, num_stages, 1))
    return keras.Model(z, w, name="mapping")


class Generator:
    def __init__(self, start_res_log2, target_res_log2):
        self.start_res_log2 = start_res_log2
        self.target_res_log2 = target_res_log2
        self.num_stages = target_res_log2 - start_res_log2 + 1
        # list of generator blocks at increasing resolution
        self.g_blocks = []
        # list of layers to convert g_block activation to RGB
        self.to_rgb = []
        # list of noise input of different resolutions into g_blocks
        self.noise_inputs = []
        # filter size to use at each stage, keys are log2(resolution)
        self.filter_nums = {
            0: 512,
            1: 512,
            2: 512,  # 4x4
            3: 512,  # 8x8
            4: 512,  # 16x16
            5: 512,  # 32x32
            6: 256,  # 64x64
```

```
            7: 128,  # 128x128
            8: 64,  # 256x256
            9: 32,  # 512x512
            10: 16,
        }  # 1024x1024

        start_res = 2 ** start_res_log2
        self.input_shape = (start_res, start_res, self.
↪filter_nums[start_res_log2])
        self.g_input = layers.Input(self.input_shape, name="generator_input")

        for i in range(start_res_log2, target_res_log2 + 1):
            filter_num = self.filter_nums[i]
            res = 2 ** i
            self.noise_inputs.append(
                layers.Input(shape=(res, res, 1), name=f"noise_{res}x{res}")
            )
            to_rgb = Sequential(
                [
                    layers.InputLayer(input_shape=(res, res, filter_num)),
                    EqualizedConv(3, 1, gain=1),
                ],
                name=f"to_rgb_{res}x{res}",
            )
            self.to_rgb.append(to_rgb)
            is_base = i == self.start_res_log2
            if is_base:
                input_shape = (res, res, self.filter_nums[i - 1])
            else:
                input_shape = (2 ** (i - 1), 2 ** (i - 1), self.filter_nums[i -␣
↪1])
            g_block = self.build_block(
                filter_num, res=res, input_shape=input_shape, is_base=is_base
            )
            self.g_blocks.append(g_block)

    def build_block(self, filter_num, res, input_shape, is_base):
        input_tensor = layers.Input(shape=input_shape, name=f"g_{res}")
        noise = layers.Input(shape=(res, res, 1), name=f"noise_{res}")
        w = layers.Input(shape=512)
        x = input_tensor

        if not is_base:
            x = layers.UpSampling2D((2, 2))(x)
            x = EqualizedConv(filter_num, 3)(x)

        x = AddNoise()([x, noise])
```

```
        x = layers.LeakyReLU(0.2)(x)
        x = InstanceNormalization()(x)
        x = AdaIN()([x, w])

        x = EqualizedConv(filter_num, 3)(x)
        x = AddNoise()([x, noise])
        x = layers.LeakyReLU(0.2)(x)
        x = InstanceNormalization()(x)
        x = AdaIN()([x, w])
        return keras.Model([input_tensor, w, noise], x,␣
↪name=f"genblock_{res}x{res}")

    def grow(self, res_log2):
        res = 2 ** res_log2

        num_stages = res_log2 - self.start_res_log2 + 1
        w = layers.Input(shape=(self.num_stages, 512), name="w")

        alpha = layers.Input(shape=(1), name="g_alpha")
        x = self.g_blocks[0]([self.g_input, w[:, 0], self.noise_inputs[0]])

        if num_stages == 1:
            rgb = self.to_rgb[0](x)
        else:
            for i in range(1, num_stages - 1):

                x = self.g_blocks[i]([x, w[:, i], self.noise_inputs[i]])

            old_rgb = self.to_rgb[num_stages - 2](x)
            old_rgb = layers.UpSampling2D((2, 2))(old_rgb)

            i = num_stages - 1
            x = self.g_blocks[i]([x, w[:, i], self.noise_inputs[i]])

            new_rgb = self.to_rgb[i](x)

            rgb = fade_in(alpha[0], new_rgb, old_rgb)

        return keras.Model(
            [self.g_input, w, self.noise_inputs, alpha],
            rgb,
            name=f"generator_{res}_x_{res}",
        )


class Discriminator:
    def __init__(self, start_res_log2, target_res_log2):
```

```
        self.start_res_log2 = start_res_log2
        self.target_res_log2 = target_res_log2
        self.num_stages = target_res_log2 - start_res_log2 + 1
        # filter size to use at each stage, keys are log2(resolution)
        self.filter_nums = {
            0: 512,
            1: 512,
            2: 512,  # 4x4
            3: 512,  # 8x8
            4: 512,  # 16x16
            5: 512,  # 32x32
            6: 256,  # 64x64
            7: 128,  # 128x128
            8: 64,  # 256x256
            9: 32,  # 512x512
            10: 16,
        }  # 1024x1024
        # list of discriminator blocks at increasing resolution
        self.d_blocks = []
        # list of layers to convert RGB into activation for d_blocks inputs
        self.from_rgb = []

        for res_log2 in range(self.start_res_log2, self.target_res_log2 + 1):
            res = 2 ** res_log2
            filter_num = self.filter_nums[res_log2]
            from_rgb = Sequential(
                [
                    layers.InputLayer(
                        input_shape=(res, res, 3), name=f"from_rgb_input_{res}"
                    ),
                    EqualizedConv(filter_num, 1),
                    layers.LeakyReLU(0.2),
                ],
                name=f"from_rgb_{res}",
            )

            self.from_rgb.append(from_rgb)

            input_shape = (res, res, filter_num)
            if len(self.d_blocks) == 0:
                d_block = self.build_base(filter_num, res)
            else:
                d_block = self.build_block(
                    filter_num, self.filter_nums[res_log2 - 1], res
                )

            self.d_blocks.append(d_block)
```

```
    def build_base(self, filter_num, res):
        input_tensor = layers.Input(shape=(res, res, filter_num),␣
↪name=f"d_{res}")
        x = minibatch_std(input_tensor)
        x = EqualizedConv(filter_num, 3)(x)
        x = layers.LeakyReLU(0.2)(x)
        x = layers.Flatten()(x)
        x = EqualizedDense(filter_num)(x)
        x = layers.LeakyReLU(0.2)(x)
        x = EqualizedDense(1)(x)
        return keras.Model(input_tensor, x, name=f"d_{res}")

    def build_block(self, filter_num_1, filter_num_2, res):
        input_tensor = layers.Input(shape=(res, res, filter_num_1),␣
↪name=f"d_{res}")
        x = EqualizedConv(filter_num_1, 3)(input_tensor)
        x = layers.LeakyReLU(0.2)(x)
        x = EqualizedConv(filter_num_2)(x)
        x = layers.LeakyReLU(0.2)(x)
        x = layers.AveragePooling2D((2, 2))(x)
        return keras.Model(input_tensor, x, name=f"d_{res}")

    def grow(self, res_log2):
        res = 2 ** res_log2
        idx = res_log2 - self.start_res_log2
        alpha = layers.Input(shape=(1), name="d_alpha")
        input_image = layers.Input(shape=(res, res, 3), name="input_image")
        x = self.from_rgb[idx](input_image)
        x = self.d_blocks[idx](x)
        if idx > 0:
            idx -= 1
            downsized_image = layers.AveragePooling2D((2, 2))(input_image)
            y = self.from_rgb[idx](downsized_image)
            x = fade_in(alpha[0], x, y)

            for i in range(idx, -1, -1):
                x = self.d_blocks[i](x)
        return keras.Model([input_image, alpha], x,␣
↪name=f"discriminator_{res}_x_{res}")
```

[ ]:
```
class StyleGAN(tf.keras.Model):
    def __init__(self, z_dim=512, target_res=64, start_res=4):
        super().__init__()
        self.z_dim = z_dim

        self.target_res_log2 = log2(target_res)
```

```
        self.start_res_log2 = log2(start_res)
        self.current_res_log2 = self.target_res_log2
        self.num_stages = self.target_res_log2 - self.start_res_log2 + 1

        self.alpha = tf.Variable(1.0, dtype=tf.float32, trainable=False,␣
↪name="alpha")

        self.mapping = Mapping(num_stages=self.num_stages)
        self.d_builder = Discriminator(self.start_res_log2, self.
↪target_res_log2)
        self.g_builder = Generator(self.start_res_log2, self.target_res_log2)
        self.g_input_shape = self.g_builder.input_shape

        self.phase = None
        self.train_step_counter = tf.Variable(0, dtype=tf.int32,␣
↪trainable=False)

        self.loss_weights = {"gradient_penalty": 10, "drift": 0.001}

    def grow_model(self, res):
        tf.keras.backend.clear_session()
        res_log2 = log2(res)
        self.generator = self.g_builder.grow(res_log2)
        self.discriminator = self.d_builder.grow(res_log2)
        self.current_res_log2 = res_log2
        print(f"\nModel resolution:{res}x{res}")

    def compile(
        self, steps_per_epoch, phase, res, d_optimizer, g_optimizer, *args,␣
↪**kwargs
    ):
        self.loss_weights = kwargs.pop("loss_weights", self.loss_weights)
        self.steps_per_epoch = steps_per_epoch
        if res != 2 ** self.current_res_log2:
            self.grow_model(res)
            self.d_optimizer = d_optimizer
            self.g_optimizer = g_optimizer

        self.train_step_counter.assign(0)
        self.phase = phase
        self.d_loss_metric = keras.metrics.Mean(name="d_loss")
        self.g_loss_metric = keras.metrics.Mean(name="g_loss")
        super().compile(*args, **kwargs)

    @property
    def metrics(self):
        return [self.d_loss_metric, self.g_loss_metric]
```

```
    def generate_noise(self, batch_size):
        noise = [
            tf.random.normal((batch_size, 2 ** res, 2 ** res, 1))
            for res in range(self.start_res_log2, self.target_res_log2 + 1)
        ]
        return noise

    def gradient_loss(self, grad):
        loss = tf.square(grad)
        loss = tf.reduce_sum(loss, axis=tf.range(1, tf.size(tf.shape(loss))))
        loss = tf.sqrt(loss)
        loss = tf.reduce_mean(tf.square(loss - 1))
        return loss

    def train_step(self, real_images):

        self.train_step_counter.assign_add(1)

        if self.phase == "TRANSITION":
            self.alpha.assign(
                tf.cast(self.train_step_counter / self.steps_per_epoch, tf.
↪float32)
            )
        elif self.phase == "STABLE":
            self.alpha.assign(1.0)
        else:
            raise NotImplementedError
        alpha = tf.expand_dims(self.alpha, 0)
        batch_size = tf.shape(real_images)[0]
        real_labels = tf.ones(batch_size)
        fake_labels = -tf.ones(batch_size)

        z = tf.random.normal((batch_size, self.z_dim))
        const_input = tf.ones(tuple([batch_size] + list(self.g_input_shape)))
        noise = self.generate_noise(batch_size)

        # generator
        with tf.GradientTape() as g_tape:
            w = self.mapping(z)
            fake_images = self.generator([const_input, w, noise, alpha])
            pred_fake = self.discriminator([fake_images, alpha])
            g_loss = wasserstein_loss(real_labels, pred_fake)

            trainable_weights = (
                self.mapping.trainable_weights + self.generator.
↪trainable_weights
```

```
            )
            gradients = g_tape.gradient(g_loss, trainable_weights)
            self.g_optimizer.apply_gradients(zip(gradients, trainable_weights))

        # discriminator
        with tf.GradientTape() as gradient_tape, tf.GradientTape() as␣
↪total_tape:
            # forward pass
            pred_fake = self.discriminator([fake_images, alpha])
            pred_real = self.discriminator([real_images, alpha])

            epsilon = tf.random.uniform((batch_size, 1, 1, 1))
            interpolates = epsilon * real_images + (1 - epsilon) * fake_images
            gradient_tape.watch(interpolates)
            pred_fake_grad = self.discriminator([interpolates, alpha])

            # calculate losses
            loss_fake = wasserstein_loss(fake_labels, pred_fake)
            loss_real = wasserstein_loss(real_labels, pred_real)
            loss_fake_grad = wasserstein_loss(fake_labels, pred_fake_grad)

            # gradient penalty
            gradients_fake = gradient_tape.gradient(loss_fake_grad,␣
↪[interpolates])
            gradient_penalty = self.loss_weights[
                "gradient_penalty"
            ] * self.gradient_loss(gradients_fake)

            # drift loss
            all_pred = tf.concat([pred_fake, pred_real], axis=0)
            drift_loss = self.loss_weights["drift"] * tf.reduce_mean(all_pred␣
↪** 2)

            d_loss = loss_fake + loss_real + gradient_penalty + drift_loss

            gradients = total_tape.gradient(
                d_loss, self.discriminator.trainable_weights
            )
            self.d_optimizer.apply_gradients(
                zip(gradients, self.discriminator.trainable_weights)
            )

        # Update metrics
        self.d_loss_metric.update_state(d_loss)
        self.g_loss_metric.update_state(g_loss)
        return {
            "d_loss": self.d_loss_metric.result(),
```

```
            "g_loss": self.g_loss_metric.result(),
        }

    def call(self, inputs: dict()):
        style_code = inputs.get("style_code", None)
        z = inputs.get("z", None)
        noise = inputs.get("noise", None)
        batch_size = inputs.get("batch_size", 1)
        alpha = inputs.get("alpha", 1.0)
        alpha = tf.expand_dims(alpha, 0)
        if style_code is None:
            if z is None:
                z = tf.random.normal((batch_size, self.z_dim))
            style_code = self.mapping(z)

        if noise is None:
            noise = self.generate_noise(batch_size)

        # self.alpha.assign(alpha)

        const_input = tf.ones(tuple([batch_size] + list(self.g_input_shape)))
        images = self.generator([const_input, style_code, noise, alpha])
        images = np.clip((images * 0.5 + 0.5) * 255, 0, 255).astype(np.uint8)

        return images
```

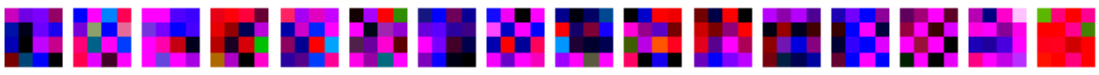
[ ]:
```
START_RES = 4
TARGET_RES = 128

style_gan = StyleGAN(start_res=START_RES, target_res=TARGET_RES)
```

[ ]:
```
def train(
    start_res=START_RES,
    target_res=TARGET_RES,
    steps_per_epoch=5000,
    display_images=True,
):
    opt_cfg = {"learning_rate": 1e-3, "beta_1": 0.0, "beta_2": 0.99, "epsilon":␣
 ↪1e-8}

    val_batch_size = 16
    val_z = tf.random.normal((val_batch_size, style_gan.z_dim))
    val_noise = style_gan.generate_noise(val_batch_size)

    start_res_log2 = int(np.log2(start_res))
    target_res_log2 = int(np.log2(target_res))
```

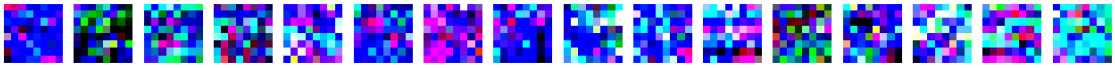
```
    for res_log2 in range(start_res_log2, target_res_log2 + 1):
        res = 2 ** res_log2
        for phase in ["TRANSITION", "STABLE"]:
            if res == start_res and phase == "TRANSITION":
                continue

            train_dl = create_dataloader(res)

            steps = int(train_step_ratio[res_log2] * steps_per_epoch)

            style_gan.compile(
                d_optimizer=tf.keras.optimizers.legacy.Adam(**opt_cfg),
                g_optimizer=tf.keras.optimizers.legacy.Adam(**opt_cfg),
                loss_weights={"gradient_penalty": 10, "drift": 0.001},
                steps_per_epoch=steps,
                res=res,
                phase=phase,
                run_eagerly=False,
            )

            prefix = f"res_{res}x{res}_{style_gan.phase}"

            ckpt_cb = keras.callbacks.ModelCheckpoint(
                f"checkpoints/stylegan_{res}x{res}.ckpt",
                save_weights_only=True,
                verbose=0,
            )
            print(phase)
            style_gan.fit(
                train_dl, epochs=1, steps_per_epoch=steps, callbacks=[ckpt_cb]
            )

            if display_images:
                images = style_gan({"z": val_z, "noise": val_noise, "alpha": 1.
↪0})
                plot_images(images, res_log2)
```

[ ]:
```
train(start_res=4, target_res=16, steps_per_epoch=1, display_images=True)
```

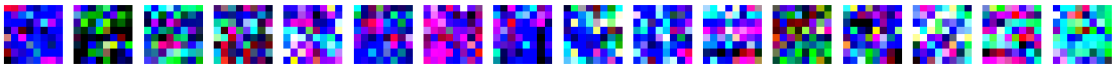
```
Model resolution:4x4
STABLE
1/1 [==============================] - 9s 9s/step - d_loss: 2.7615 - g_loss:
0.8970
```



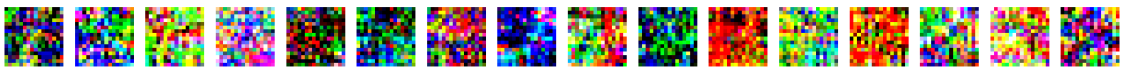
```
Model resolution:8x8
TRANSITION
1/1 [==============================] - 8s 8s/step - d_loss: 5.4979 - g_loss:
1.7689
```



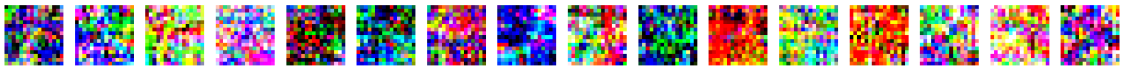
```
STABLE
1/1 [==============================] - 4s 4s/step - d_loss: 0.6347 - g_loss:
5.9936
```



```
Model resolution:16x16
TRANSITION
1/1 [==============================] - 10s 10s/step - d_loss: 5.1118 - g_loss:
5.5240
```



```
STABLE

WARNING:tensorflow:5 out of the last 5 calls to <function
Model.make_train_function.<locals>.train_function at 0x7ac730eb7910> triggered
tf.function retracing. Tracing is expensive and the excessive number of tracings
could be due to (1) creating @tf.function repeatedly in a loop, (2) passing
tensors with different shapes, (3) passing Python objects instead of tensors.
For (1), please define your @tf.function outside of the loop. For (2),
@tf.function has reduce_retracing=True option that can avoid unnecessary
retracing. For (3), please refer to
https://www.tensorflow.org/guide/function#controlling_retracing and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.

1/1 [==============================] - 6s 6s/step - d_loss: 0.9506 - g_loss:
11.1828
```



[ ]:
```
url = "https://github.com/soon-yau/stylegan_keras/releases/download/
 ↪keras_example_v1.0/stylegan_128x128.ckpt.zip"

weights_path = keras.utils.get_file(
    "stylegan_128x128.ckpt.zip",
    url,
    extract=True,
    cache_dir=os.path.abspath("."),
    cache_subdir="pretrained",
)

style_gan.grow_model(128)
style_gan.load_weights(os.path.join("pretrained/stylegan_128x128.ckpt"))

tf.random.set_seed(196)
batch_size = 2
z = tf.random.normal((batch_size, style_gan.z_dim))
w = style_gan.mapping(z)
noise = style_gan.generate_noise(batch_size=batch_size)
images = style_gan({"style_code": w, "noise": noise, "alpha": 1.0})
plot_images(images, 5)
```

```
Downloading data from https://github.com/soon-yau/stylegan_keras/releases/downlo
ad/keras_example_v1.0/stylegan_128x128.ckpt.zip
540534982/540534982 [==============================] - 11s 0us/step

Model resolution:128x128
```

[ ]:
```
alpha = 0.4
w_mix = np.expand_dims(alpha * w[0] + (1 - alpha) * w[1], 0)
noise_a = [np.expand_dims(n[0], 0) for n in noise]
mix_images = style_gan({"style_code": w_mix, "noise": noise_a})
image_row = np.hstack([images[0], images[1], mix_images[0]])
plt.figure(figsize=(9, 3))
plt.imshow(image_row)
plt.axis("off")
```

[ ]:
```
(-0.5, 383.5, 127.5, -0.5)
```