DIV2K

```
import os
import tensorflow as tf

from tensorflow.python.data.experimental import AUTOTUNE


class DIV2K:
    def __init__(self,
                 scale=2,
                 subset='train',
                 downgrade='bicubic',
                 images_dir='.div2k/images',
                 caches_dir='.div2k/caches'):

        self._ntire_2018 = True

        _scales = [2, 3, 4, 8]

        if scale in _scales:
            self.scale = scale
        else:
            raise ValueError(f'scale must be in ${_scales}')

        if subset == 'train':
            self.image_ids = range(1, 801)
        elif subset == 'valid':
            self.image_ids = range(801, 901)
        else:
            raise ValueError("subset must be 'train' or 'valid'")

        _downgrades_a = ['bicubic', 'unknown']
        _downgrades_b = ['mild', 'difficult']

        if scale == 8 and downgrade != 'bicubic':
            raise ValueError(f'scale 8 only allowed for bicubic downgrade')

        if downgrade in _downgrades_b and scale != 4:
            raise ValueError(f'{downgrade} downgrade requires scale 4')

        if downgrade == 'bicubic' and scale == 8:
            self.downgrade = 'x8'
        elif downgrade in _downgrades_b:
            self.downgrade = downgrade
        else:
            self.downgrade = downgrade
            self._ntire_2018 = False

        self.subset = subset
        self.images_dir = images_dir
        self.caches_dir = caches_dir

        os.makedirs(images_dir, exist_ok=True)
        os.makedirs(caches_dir, exist_ok=True)

    def __len__(self):
        return len(self.image_ids)

    def dataset(self, batch_size=16, repeat_count=None, random_transform=True):
        ds = tf.data.Dataset.zip((self.lr_dataset(), self.hr_dataset()))
        if random_transform:
            ds = ds.map(lambda lr, hr: random_crop(lr, hr, scale=self.scale), num_parallel_
            ds = ds.map(random_rotate, num_parallel_calls=AUTOTUNE)
            ds = ds.map(random_flip, num_parallel_calls=AUTOTUNE)
        ds = ds.batch(batch_size)
        ds = ds.repeat(repeat_count)
        ds = ds.prefetch(buffer_size=AUTOTUNE)
        return ds

    def hr_dataset(self):
        if not os.path.exists(self._hr_images_dir()):
            download_archive(self._hr_images_archive(), self.images_dir, extract=True)

        ds = self._images_dataset(self._hr_image_files()).cache(self._hr_cache_file())

        if not os.path.exists(self._hr_cache_index()):
            self._populate_cache(ds, self._hr_cache_file())

        return ds

    def lr_dataset(self):
        if not os.path.exists(self._lr_images_dir()):
            download_archive(self._lr_images_archive(), self.images_dir, extract=True)

        ds = self._images_dataset(self._lr_image_files()).cache(self._lr_cache_file())

        if not os.path.exists(self._lr_cache_index()):
            self._populate_cache(ds, self._lr_cache_file())

        return ds

    def _hr_cache_file(self):
        return os.path.join(self.caches_dir, f'DIV2K_{self.subset}_HR.cache')

    def _lr_cache_file(self):
        return os.path.join(self.caches_dir, f'DIV2K_{self.subset}_LR_{self.downgrade}_X{s

    def _hr_cache_index(self):
        return f'{self._hr_cache_file()}.index'

    def _lr_cache_index(self):
        return f'{self._lr_cache_file()}.index'

    def _hr_image_files(self):
        images_dir = self._hr_images_dir()
        return [os.path.join(images_dir, f'{image_id:04}.png') for image_id in self.image_

    def _lr_image_files(self):
        images_dir = self._lr_images_dir()
        return [os.path.join(images_dir, self._lr_image_file(image_id)) for image_id in se

    def _lr_image_file(self, image_id):
        if not self._ntire_2018 or self.scale == 8:
            return f'{image_id:04}x{self.scale}.png'
        else:
            return f'{image_id:04}x{self.scale}{self.downgrade[0]}.png'

    def _hr_images_dir(self):
        return os.path.join(self.images_dir, f'DIV2K_{self.subset}_HR')

    def _lr_images_dir(self):
        if self._ntire_2018:
            return os.path.join(self.images_dir, f'DIV2K_{self.subset}_LR_{self.downgrade}
        else:
            return os.path.join(self.images_dir, f'DIV2K_{self.subset}_LR_{self.downgrade}

    def _hr_images_archive(self):
        return f'DIV2K_{self.subset}_HR.zip'

    def _lr_images_archive(self):
        if self._ntire_2018:
            return f'DIV2K_{self.subset}_LR_{self.downgrade}.zip'
        else:
            return f'DIV2K_{self.subset}_LR_{self.downgrade}_X{self.scale}.zip'

    @staticmethod
    def _images_dataset(image_files):
        ds = tf.data.Dataset.from_tensor_slices(image_files)
        ds = ds.map(tf.io.read_file)
        ds = ds.map(lambda x: tf.image.decode_png(x, channels=3), num_parallel_calls=AUTOT
        return ds

    @staticmethod
    def _populate_cache(ds, cache_file):
        print(f'Caching decoded images in {cache_file} ...')
        for _ in ds: pass
        print(f'Cached decoded images in {cache_file}.')


# -----------------------------------------------------------
#  Transformations
# -----------------------------------------------------------


def random_crop(lr_img, hr_img, hr_crop_size=96, scale=2):
    lr_crop_size = hr_crop_size // scale
    lr_img_shape = tf.shape(lr_img)[:2]

    lr_w = tf.random.uniform(shape=(), maxval=lr_img_shape[1] - lr_crop_size + 1, dtype=tf
    lr_h = tf.random.uniform(shape=(), maxval=lr_img_shape[0] - lr_crop_size + 1, dtype=tf
    hr_w = lr_w * scale
    hr_h = lr_h * scale

    lr_img_cropped = lr_img[lr_h:lr_h + lr_crop_size, lr_w:lr_w + lr_crop_size]
    hr_img_cropped = hr_img[hr_h:hr_h + hr_crop_size, hr_w:hr_w + hr_crop_size]

    return lr_img_cropped, hr_img_cropped


def random_flip(lr_img, hr_img):
    rn = tf.random.uniform(shape=(), maxval=1)
    return tf.cond(rn < 0.5,
                   lambda: (lr_img, hr_img),
                   lambda: (tf.image.flip_left_right(lr_img),
                            tf.image.flip_left_right(hr_img)))


def random_rotate(lr_img, hr_img):
    rn = tf.random.uniform(shape=(), maxval=4, dtype=tf.int32)
    return tf.image.rot90(lr_img, rn), tf.image.rot90(hr_img, rn)


# -----------------------------------------------------------
#  IO
# -----------------------------------------------------------


def download_archive(file, target_dir, extract=True):
    source_url = f'http://data.vision.ee.ethz.ch/cvl/DIV2K/{file}'
    target_dir = os.path.abspath(target_dir)
    tf.keras.utils.get_file(file, source_url, cache_subdir=target_dir, extract=extract)
    os.remove(os.path.join(target_dir, file))
```

COMMON

```
import numpy as np
import tensorflow as tf


DIV2K_RGB_MEAN = np.array([0.4488, 0.4371, 0.4040]) * 255


def resolve_single(model, lr):
    return resolve(model, tf.expand_dims(lr, axis=0))[0]


def resolve(model, lr_batch):
    lr_batch = tf.cast(lr_batch, tf.float32)
    sr_batch = model(lr_batch)
    sr_batch = tf.clip_by_value(sr_batch, 0, 255)
    sr_batch = tf.round(sr_batch)
    sr_batch = tf.cast(sr_batch, tf.uint8)
    return sr_batch


def evaluate(model, dataset):
    psnr_values = []
    for lr, hr in dataset:
        sr = resolve(model, lr)
        psnr_value = psnr(hr, sr)[0]
        psnr_values.append(psnr_value)
    return tf.reduce_mean(psnr_values)


# ---------------------------------------
#  Normalization
# ---------------------------------------


def normalize(x, rgb_mean=DIV2K_RGB_MEAN):
    return (x - rgb_mean) / 127.5


def denormalize(x, rgb_mean=DIV2K_RGB_MEAN):
    return x * 127.5 + rgb_mean


def normalize_01(x):
    """Normalizes RGB images to [0, 1]."""
    return x / 255.0


def normalize_m11(x):
    """Normalizes RGB images to [-1, 1]."""
    return x / 127.5 - 1


def denormalize_m11(x):
    """Inverse of normalize_m11."""
    return (x + 1) * 127.5

def psnr(x1, x2):
    return tf.image.psnr(x1, x2, max_val=255)

def pixel_shuffle(scale):
    return lambda x: tf.nn.depth_to_space(x, scale)
```

SRGAN

```
from tensorflow.python.keras.layers import Add, BatchNormalization, Conv2D, Dense, Flatten
from tensorflow.python.keras.models import Model
from tensorflow.python.keras.applications.vgg19 import VGG19
```

```
LR_SIZE = 24
HR_SIZE = 96


def upsample(x_in, num_filters):
    x = Conv2D(num_filters, kernel_size=3, padding='same')(x_in)
    x = Lambda(pixel_shuffle(scale=2))(x)
    return PReLU(shared_axes=[1, 2])(x)


def res_block(x_in, num_filters, momentum=0.8):
    x = Conv2D(num_filters, kernel_size=3, padding='same')(x_in)
    x = BatchNormalization(momentum=momentum)(x)
    x = PReLU(shared_axes=[1, 2])(x)
    x = Conv2D(num_filters, kernel_size=3, padding='same')(x)
    x = BatchNormalization(momentum=momentum)(x)
    x = Add()([x_in, x])
    return x


def sr_resnet(num_filters=64, num_res_blocks=16):
    x_in = Input(shape=(None, None, 3))
    x = Lambda(normalize_01)(x_in)

    x = Conv2D(num_filters, kernel_size=9, padding='same')(x)
    x = x_1 = PReLU(shared_axes=[1, 2])(x)

    for _ in range(num_res_blocks):
        x = res_block(x, num_filters)

    x = Conv2D(num_filters, kernel_size=3, padding='same')(x)
    x = BatchNormalization()(x)
    x = Add()([x_1, x])

    x = upsample(x, num_filters * 4)
    x = upsample(x, num_filters * 4)

    x = Conv2D(3, kernel_size=9, padding='same', activation='tanh')(x)
    x = Lambda(denormalize_m11)(x)

    return Model(x_in, x)

generator = sr_resnet


def discriminator_block(x_in, num_filters, strides=1, batchnorm=True, momentum=0.8):
    x = Conv2D(num_filters, kernel_size=3, strides=strides, padding='same')(x_in)
    if batchnorm:
        x = BatchNormalization(momentum=momentum)(x)
    return LeakyReLU(alpha=0.2)(x)


def discriminator(num_filters=64):
    x_in = Input(shape=(HR_SIZE, HR_SIZE, 3))
    x = Lambda(normalize_m11)(x_in)

    x = discriminator_block(x, num_filters, batchnorm=False)
    x = discriminator_block(x, num_filters, strides=2)

    x = discriminator_block(x, num_filters * 2)
    x = discriminator_block(x, num_filters * 2, strides=2)

    x = discriminator_block(x, num_filters * 4)
    x = discriminator_block(x, num_filters * 4, strides=2)

    x = discriminator_block(x, num_filters * 8)
    x = discriminator_block(x, num_filters * 8, strides=2)

    x = Flatten()(x)

    x = Dense(1024)(x)
    x = LeakyReLU(alpha=0.2)(x)
    x = Dense(1, activation='sigmoid')(x)

    return Model(x_in, x)


def vgg_22():
    return _vgg(5)


def vgg_54():
    return _vgg(20)


def _vgg(output_layer):
    vgg = VGG19(input_shape=(None, None, 3), include_top=False)
    return Model(vgg.input, vgg.layers[output_layer].output)
```

UTILS

```
import numpy as np
import matplotlib.pyplot as plt

from PIL import Image


def load_image(path):
    return np.array(Image.open(path))


def plot_sample(lr, sr):
    plt.figure(figsize=(20, 10))
    images = [lr, sr]
    titles = ['LR', f'SR (x{sr.shape[0] // lr.shape[0]})']

    for i, (img, title) in enumerate(zip(images, titles)):
        plt.subplot(1, 2, i+1)
        plt.imshow(img)
        plt.title(title)
        plt.xticks([])
        plt.yticks([])
```

TRAIN

```
import time
import tensorflow as tf

from tensorflow.keras.applications.vgg19 import preprocess_input
from tensorflow.keras.losses import BinaryCrossentropy
from tensorflow.keras.losses import MeanAbsoluteError
from tensorflow.keras.losses import MeanSquaredError
from tensorflow.keras.metrics import Mean
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.optimizers.schedules import PiecewiseConstantDecay


class Trainer:
    def __init__(self,
                 model,
                 loss,
                 learning_rate,
                 checkpoint_dir='./ckpt/edsr'):

        self.now = None
        self.loss = loss
        self.checkpoint = tf.train.Checkpoint(step=tf.Variable(0),
                                              psnr=tf.Variable(-1.0),
                                              optimizer=Adam(learning_rate),
                                              model=model)
        self.checkpoint_manager = tf.train.CheckpointManager(checkpoint=self.checkpoint,
                                                             directory=checkpoint_dir,
                                                             max_to_keep=3)

        self.restore()

    @property
    def model(self):
        return self.checkpoint.model

    def train(self, train_dataset, valid_dataset, steps, evaluate_every=1000, save_best_on
        loss_mean = Mean()

        ckpt_mgr = self.checkpoint_manager
        ckpt = self.checkpoint
        self.now = time.perf_counter()

        for lr, hr in train_dataset.take(steps - ckpt.step.numpy()):
            ckpt.step.assign_add(1)
            step = ckpt.step.numpy()

            loss = self.train_step(lr, hr)
            loss_mean(loss)

            if step % evaluate_every == 0:
                loss_value = loss_mean.result()
                loss_mean.reset_states()

                # Compute PSNR on validation dataset
                psnr_value = self.evaluate(valid_dataset)

                duration = time.perf_counter() - self.now
                print(f'{step}/{steps}: loss = {loss_value.numpy():.3f}, PSNR = {psnr_valu

                if save_best_only and psnr_value <= ckpt.psnr:
                    self.now = time.perf_counter()
                    # skip saving checkpoint, no PSNR improvement
                    continue

                ckpt.psnr = psnr_value
                ckpt_mgr.save()

                self.now = time.perf_counter()

    @tf.function
    def train_step(self, lr, hr):
        with tf.GradientTape() as tape:
            lr = tf.cast(lr, tf.float32)
            hr = tf.cast(hr, tf.float32)

            sr = self.checkpoint.model(lr, training=True)
            loss_value = self.loss(hr, sr)

        gradients = tape.gradient(loss_value, self.checkpoint.model.trainable_variables)
        self.checkpoint.optimizer.apply_gradients(zip(gradients, self.checkpoint.model.tra

        return loss_value

    def evaluate(self, dataset):
        return evaluate(self.checkpoint.model, dataset)

    def restore(self):
        if self.checkpoint_manager.latest_checkpoint:
            self.checkpoint.restore(self.checkpoint_manager.latest_checkpoint)
            print(f'Model restored from checkpoint at step {self.checkpoint.step.numpy()}.


class EdsrTrainer(Trainer):
    def __init__(self,
                 model,
                 checkpoint_dir,
                 learning_rate=PiecewiseConstantDecay(boundaries=[200000], values=[1e-4, 5
        super().__init__(model, loss=MeanAbsoluteError(), learning_rate=learning_rate, che

    def train(self, train_dataset, valid_dataset, steps=300000, evaluate_every=1000, save_
        super().train(train_dataset, valid_dataset, steps, evaluate_every, save_best_only)


class WdsrTrainer(Trainer):
    def __init__(self,
                 model,
                 checkpoint_dir,
                 learning_rate=PiecewiseConstantDecay(boundaries=[200000], values=[1e-3, 5
        super().__init__(model, loss=MeanAbsoluteError(), learning_rate=learning_rate, che

    def train(self, train_dataset, valid_dataset, steps=300000, evaluate_every=1000, save_
        super().train(train_dataset, valid_dataset, steps, evaluate_every, save_best_only)


class SrganGeneratorTrainer(Trainer):
    def __init__(self,
                 model,
                 checkpoint_dir,
                 learning_rate=1e-4):
        super().__init__(model, loss=MeanSquaredError(), learning_rate=learning_rate, chec

    def train(self, train_dataset, valid_dataset, steps=1000000, evaluate_every=1000, save
        super().train(train_dataset, valid_dataset, steps, evaluate_every, save_best_only)


class SrganTrainer:
    #
    # TODO: model and optimizer checkpoints
    #
    def __init__(self,
                 generator,
                 discriminator,
                 content_loss='VGG54',
                 learning_rate=PiecewiseConstantDecay(boundaries=[100000], values=[1e-4, 1

        if content_loss == 'VGG22':
            self.vgg = srgan.vgg_22()
        elif content_loss == 'VGG54':
            self.vgg = srgan.vgg_54()
        else:
            raise ValueError("content_loss must be either 'VGG22' or 'VGG54'")

        self.content_loss = content_loss
        self.generator = generator
        self.discriminator = discriminator
        self.generator_optimizer = Adam(learning_rate=learning_rate)
        self.discriminator_optimizer = Adam(learning_rate=learning_rate)

        self.binary_cross_entropy = BinaryCrossentropy(from_logits=False)
        self.mean_squared_error = MeanSquaredError()

    def train(self, train_dataset, steps=200000):
        pls_metric = Mean()
        dls_metric = Mean()
        step = 0

        for lr, hr in train_dataset.take(steps):
            step += 1

            pl, dl = self.train_step(lr, hr)
            pls_metric(pl)
            dls_metric(dl)

            if step % 50 == 0:
                print(f'{step}/{steps}, perceptual loss = {pls_metric.result():.4f}, discr
                pls_metric.reset_states()
                dls_metric.reset_states()

    @tf.function
    def train_step(self, lr, hr):
        with tf.GradientTape() as gen_tape, tf.GradientTape() as disc_tape:
            lr = tf.cast(lr, tf.float32)
            hr = tf.cast(hr, tf.float32)

            sr = self.generator(lr, training=True)

            hr_output = self.discriminator(hr, training=True)
            sr_output = self.discriminator(sr, training=True)

            con_loss = self._content_loss(hr, sr)
            gen_loss = self._generator_loss(sr_output)
            perc_loss = con_loss + 0.001 * gen_loss
            disc_loss = self._discriminator_loss(hr_output, sr_output)

        gradients_of_generator = gen_tape.gradient(perc_loss, self.generator.trainable_var
        gradients_of_discriminator = disc_tape.gradient(disc_loss, self.discriminator.trai

        self.generator_optimizer.apply_gradients(zip(gradients_of_generator, self.generato
        self.discriminator_optimizer.apply_gradients(zip(gradients_of_discriminator, self.

        return perc_loss, disc_loss

    @tf.function
    def _content_loss(self, hr, sr):
        sr = preprocess_input(sr)
        hr = preprocess_input(hr)
        sr_features = self.vgg(sr) / 12.75
        hr_features = self.vgg(hr) / 12.75
        return self.mean_squared_error(hr_features, sr_features)

    def _generator_loss(self, sr_out):
        return self.binary_cross_entropy(tf.ones_like(sr_out), sr_out)

    def _discriminator_loss(self, hr_out, sr_out):
        hr_loss = self.binary_cross_entropy(tf.ones_like(hr_out), hr_out)
        sr_loss = self.binary_cross_entropy(tf.zeros_like(sr_out), sr_out)
        return hr_loss + sr_loss
```

```
from google.colab import files
uploaded = files.upload()
```

Выбрать файлы 0869x4-crop.png

- **0869x4-crop.png**(image/png) - 27075 bytes, last modified: 25.10.2021 - 100% done

```
Saving 0869x4-crop.png to 0869x4-crop.png
```

```
from google.colab import files
uploaded = files.upload()
```

Выбрать файлы gan_generator.h5

- **gan_generator.h5**(n/a) - 6519624 bytes, last modified: 13.06.2019 - 100% done

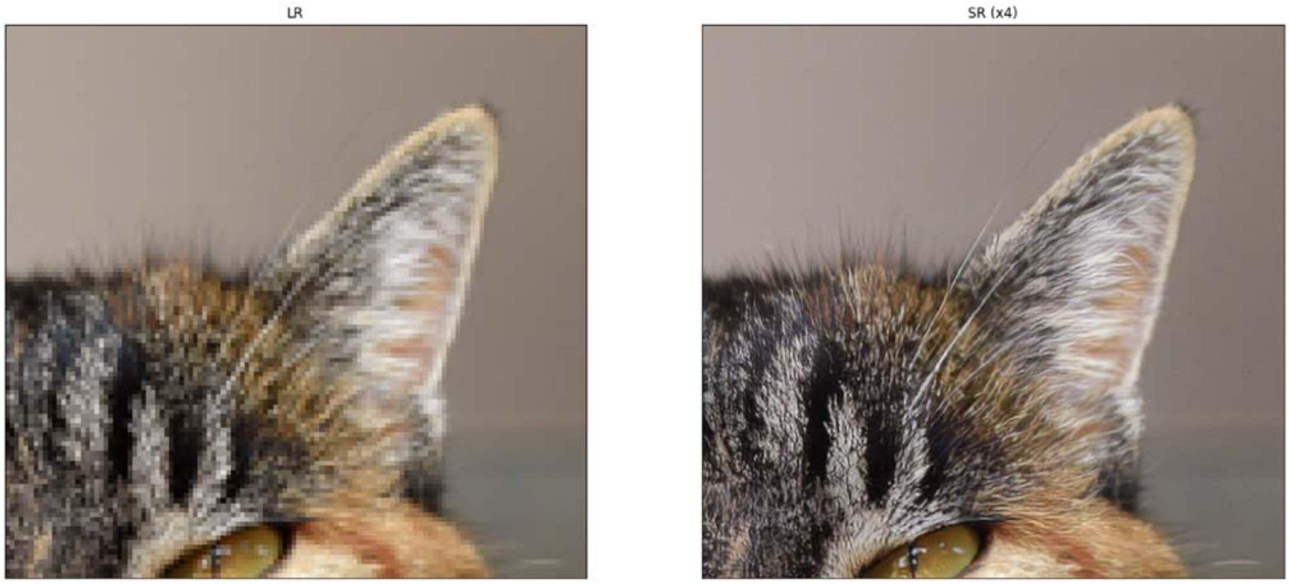
```
Saving gan_generator.h5 to gan_generator.h5
```

DEMO SRGAN надо загрузить модель gan_generator.h5

```
model = generator()
model.load_weights('gan_generator.h5')

lr = load_image('0869x4-crop.png')
sr = resolve_single(model, lr)

plot_sample(lr, sr)
```



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