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In [34]: ##### Copyright 2019 The TensorFlow Authors.

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In [35]: # !pip install git+https://github.com/tensorflow/examples.git
# !pip install tensorflow_datasets


In [36]: import tensorflow as tf


In [37]: from __future__ import absolute_import, division, print_function, unicode_literals

from tensorflow_examples.models.pix2pix import pix2pix

import tensorflow_datasets as tfds
tfds.disable_progress_bar()

from IPython.display import clear_output
import matplotlib.pyplot as plt

import tensorflow as tf
tf.config.experimental.set_visible_devices([], 'GPU')


In [38]: # Загрузка датасета Oxford-IIIT Pets
dataset, info = tfds.load('oxford_iiit_pet:3.*.*', with_info=True)


In [39]: def normalize(input_image, input_mask):
    input_image = tf.cast(input_image, tf.float32) / 255.0
    input_mask -= 1
    return input_image, input_mask


In [40]: @tf.function
def load_image_train(datapoint):
    input_image = tf.image.resize(datapoint['image'], (128, 128))
    input_mask = tf.image.resize(datapoint['segmentation_mask'], (128, 128))

    if tf.random.uniform(()) > 0.5:
        input_image = tf.image.flip_left_right(input_image)
        input_mask = tf.image.flip_left_right(input_mask)

    input_image, input_mask = normalize(input_image, input_mask)

    return input_image, input_mask
```

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In [41]: def load_image_test(datapoint):
         input_image = tf.image.resize(datapoint['image'], (128, 128))
         input_mask = tf.image.resize(datapoint['segmentation_mask'], (128, 128))

         input_image, input_mask = normalize(input_image, input_mask)

         return input_image, input_mask

In [42]: # Датасет уже содержит необходимые тестовый и тренировочный сплиты, поэтому
         давайте использовать их.

In [43]: TRAIN_LENGTH = info.splits['train'].num_examples
         BATCH_SIZE = 128
         BUFFER_SIZE = 1000
         STEPS_PER_EPOCH = TRAIN_LENGTH // BATCH_SIZE

In [44]: train = dataset['train'].map(load_image_train, num_parallel_calls=tf.data.ex
         perimental.AUTOTUNE)
         test = dataset['test'].map(load_image_test)

In [45]: train_dataset = train.cache().shuffle(BUFFER_SIZE).batch(BATCH_SIZE).repeat
         ()
         train_dataset = train_dataset.prefetch(buffer_size=tf.data.experimental.AUTO
         TUNE)
         test_dataset = test.batch(BATCH_SIZE)

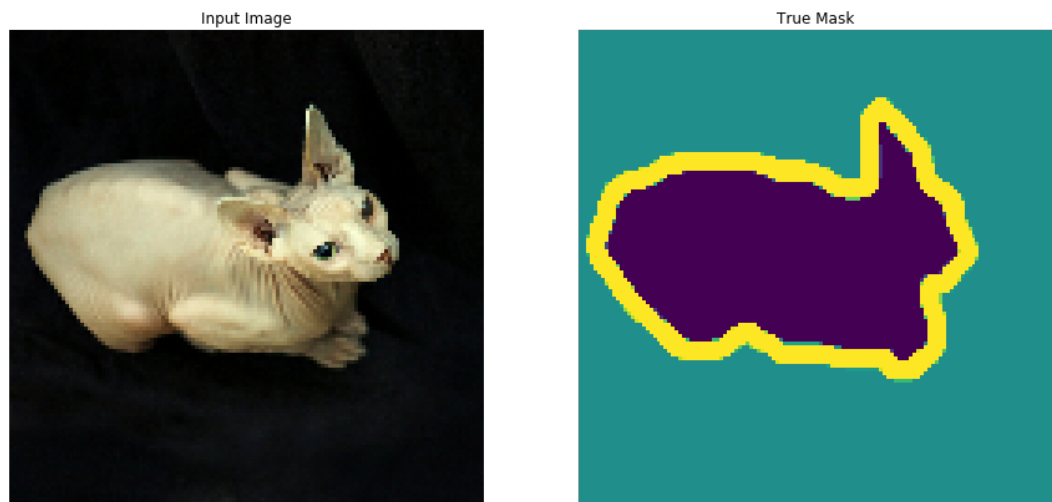
In [46]: # Давайте посмотрим на пример изображения из датасета и соответствующую ему м
         аску из датасета.

In [47]: def display(display_list):
         plt.figure(figsize=(15, 15))

         title = ['Input Image', 'True Mask', 'Predicted Mask']

         for i in range(len(display_list)):
             plt.subplot(1, len(display_list), i+1)
             plt.title(title[i])
             plt.imshow(tf.keras.preprocessing.image.array_to_img(display_list[i]))
             plt.axis('off')
         plt.show()
```

```
In [48]: for image, mask in train.take(1):  
        sample_image, sample_mask = image, mask  
        display([sample_image, sample_mask])
```



```
In [49]: # Определение модели  
        # энкодером будет предтренированный MobileNetV2
```

```
In [50]: OUTPUT_CHANNELS = 3
```

```
In [51]: base_model = tf.keras.applications.MobileNetV2(input_shape=[128, 128, 3], include_top=False)  
  
        # Use the activations of these layers  
        layer_names = [  
            'block_1_expand_relu', # 64x64  
            'block_3_expand_relu', # 32x32  
            'block_6_expand_relu', # 16x16  
            'block_13_expand_relu', # 8x8  
            'block_16_project', # 4x4  
        ]  
        layers = [base_model.get_layer(name).output for name in layer_names]  
  
        # Create the feature extraction model  
        down_stack = tf.keras.Model(inputs=base_model.input, outputs=layers)  
  
        down_stack.trainable = False
```

```
In [52]: # Декодер/апсемплер это просто серия апсемпл блоков имплементированны в TensorFlow examples.
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```
In [53]: up_stack = [  
    pix2pix.upsample(512, 3), # 4x4 -> 8x8  
    pix2pix.upsample(256, 3), # 8x8 -> 16x16  
    pix2pix.upsample(128, 3), # 16x16 -> 32x32  
    pix2pix.upsample(64, 3), # 32x32 -> 64x64  
]
```

```
In [54]: def unet_model(output_channels):
          inputs = tf.keras.layers.Input(shape=[128, 128, 3])
          x = inputs

          # Downsampling through the model
          skips = down_stack(x)
          x = skips[-1]
          skips = reversed(skips[:-1])

          # Upsampling and establishing the skip connections
          for up, skip in zip(up_stack, skips):
              x = up(x)
              concat = tf.keras.layers.Concatenate()
              x = concat([x, skip])

          # This is the last layer of the model
          last = tf.keras.layers.Conv2DTranspose(
              output_channels, 3, strides=2,
              padding='same') #64x64 -> 128x128

          x = last(x)

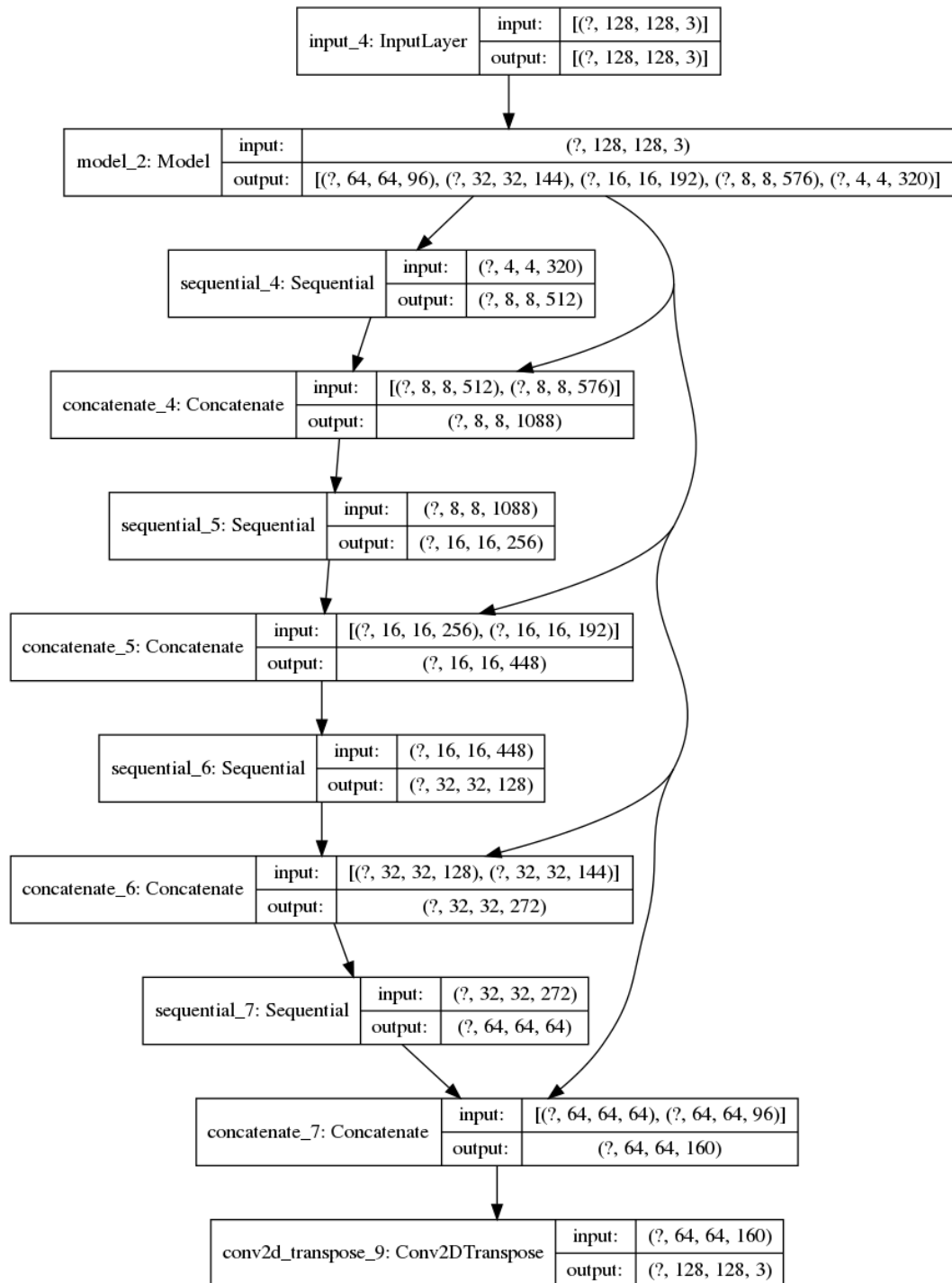
          return tf.keras.Model(inputs=inputs, outputs=x)
```

```
In [55]: # Тренировка модели
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```
In [56]: model = unet_model(OUTPUT_CHANNELS)
          model.compile(optimizer='adam',
                        loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits
                        =True),
                        metrics=['accuracy'])
```

In [57]: `tf.keras.utils.plot_model(model, show_shapes=True)`

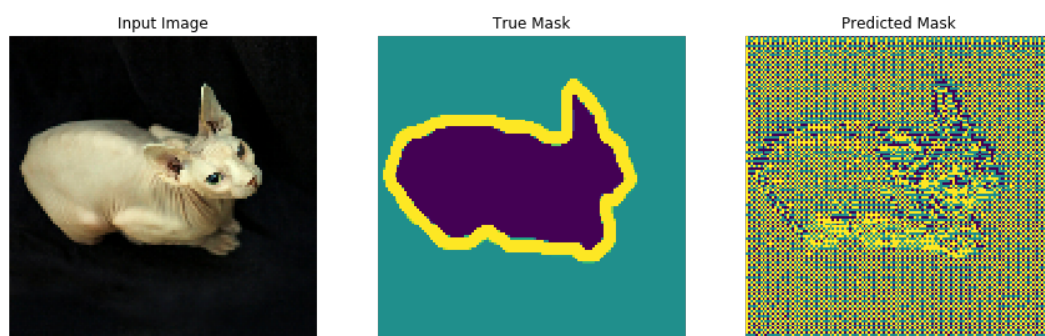
Out[57]:



In [58]: `def create_mask(pred_mask):
 pred_mask = tf.argmax(pred_mask, axis=-1)
 pred_mask = pred_mask[..., tf.newaxis]
 return pred_mask[0]`

```
In [59]: def show_predictions(dataset=None, num=1):
         if dataset:
             for image, mask in dataset.take(num):
                 pred_mask = model.predict(image)
                 display([image[0], mask[0], create_mask(pred_mask)])
         else:
             display([sample_image, sample_mask,
                       create_mask(model.predict(sample_image[tf.newaxis, ...]))])
```

```
In [60]: show_predictions()
```



```
In [61]: # Давайте осуществлять мониторинг того как улучшается работа модели в процес
се обучения. Для завершения этой задачи callback функция определена ниже.
```

```
In [62]: class DisplayCallback(tf.keras.callbacks.Callback):
         def on_epoch_end(self, epoch, logs=None):
             clear_output(wait=True)
             show_predictions()
             print('\nSample Prediction after epoch {}'.format(epoch+1))
```

```
In [ ]: EPOCHS = 5 # увеличьте при необходимости
         VAL_SUBSPLITS = 5
         VALIDATION_STEPS = info.splits['test'].num_examples//BATCH_SIZE//VAL_SUBSPLITS

         model_history = model.fit(train_dataset, epochs=EPOCHS,
                                   steps_per_epoch=STEPS_PER_EPOCH,
                                   validation_steps=VALIDATION_STEPS,
                                   validation_data=test_dataset,
                                   callbacks=[DisplayCallback()])
```

Train for 28 steps, validate for 5 steps

Epoch 1/5

4/28 [==>.....] - ETA: 4:44 - loss: 1.2255 - accuracy: 0.4221

```
In [ ]: loss = model_history.history['loss']
         val_loss = model_history.history['val_loss']

         epochs = range(EPOCHS)

         plt.figure()
         plt.plot(epochs, loss, 'r', label='Training loss')
         plt.plot(epochs, val_loss, 'bo', label='Validation loss')
         plt.title('Training and Validation Loss')
         plt.xlabel('Epoch')
         plt.ylabel('Loss Value')
         plt.ylim([0, 1])
         plt.legend()
         plt.show()
```

In [32]: `# Make predictions`

```
In [33]: show_predictions(test_dataset, 5)
```



In []: