cats-vs-dogs

December 5, 2022

Credit for helping me get the data set loaded in: https://www.kaggle.com/code/mauricioasperti/cats-vs-dogs-image-classification/notebook

Credit for helping me figure out how to find the distribution of target classes: https://stackoverflow.com/questions/60876805/how-to-show-the-class-distribution-in-dataset-object-in-tensorflow/60877708#60877708

1 Imports

[5]:
```
import io
import openpyxl
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
from tensorflow.keras.models import Sequential
```

2 Loading in the data set

[6]:
```
#Copying current content to new editable directory
!cp -r "../input/microsoft-catsvsdogs-dataset/PetImages/" "/kaggle/working/"

#Selecting dataset directory
ds_pet_dir = "/kaggle/working/PetImages/"

#Generating a dataset
ds_pet = tf.keras.preprocessing.image_dataset_from_directory(ds_pet_dir)
```

```
Found 25000 files belonging to 2 classes.
```

```
2022-12-05 05:29:53.005493: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:53.120536: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:53.121286: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:53.123286: I tensorflow/core/platform/cpu_feature_guard.cc:142]
This TensorFlow binary is optimized with oneAPI Deep Neural Network Library
(oneDNN) to use the following CPU instructions in performance-critical
operations:  AVX2 AVX512F FMA
To enable them in other operations, rebuild TensorFlow with the appropriate
compiler flags.
2022-12-05 05:29:53.123575: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:53.124297: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:53.124964: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:55.279875: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:55.280706: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:55.281412: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node
read from SysFS had negative value (-1), but there must be at least one NUMA
node, so returning NUMA node zero
2022-12-05 05:29:55.282047: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1510] Created device
/job:localhost/replica:0/task:0/device:GPU:0 with 15401 MB memory:  -> device:
0, name: Tesla P100-PCIE-16GB, pci bus id: 0000:00:04.0, compute capability: 6.0
```

[84]:
```
ds_pet.class_names
```

[84]:
```
['Cat', 'Dog']
```

3 Divide Into train and test

[7]:
```
#Defining parameters for the loader:
batch_size = 32
img_height = 180
img_width = 180

#Filtering out corrupted images
import os
num_skipped = 0
for folder_name in ("Cat", "Dog"):
    folder_path = os.path.join(ds_pet_dir, folder_name)
    for fname in os.listdir(folder_path):
        fpath = os.path.join(folder_path, fname)
        try:
            fobj = open(fpath, "rb")
            is_jfif = tf.compat.as_bytes("JFIF") in fobj.peek(10)
        finally:
            fobj.close()
        if not is_jfif:
            num_skipped += 1
            # Delete corrupted image
            os.remove(fpath)
print("Deleted %d images" % num_skipped)

#Data augmentation
data_augmentation = keras.Sequential([
    layers.experimental.preprocessing.RandomFlip("horizontal",␣
 ↪input_shape=(img_height, img_width, 3)),
    layers.experimental.preprocessing.RandomRotation(0.1),
    layers.experimental.preprocessing.RandomZoom(0.1)])

#Setting train/test split
ds_pet_train = tf.keras.preprocessing.image_dataset_from_directory(
    ds_pet_dir,
    validation_split=0.2,
    subset="training",
    seed=1337,
    image_size=(img_height, img_width),
    batch_size=batch_size)
ds_pet_test = tf.keras.preprocessing.image_dataset_from_directory(
```

```
    ds_pet_dir,
    validation_split=0.2,
    subset="validation",
    seed=1337,
    image_size=(img_height, img_width),
    batch_size=batch_size)
```

```
Deleted 1590 images
Found 23410 files belonging to 2 classes.
Using 18728 files for training.
Found 23410 files belonging to 2 classes.
Using 4682 files for validation.
```

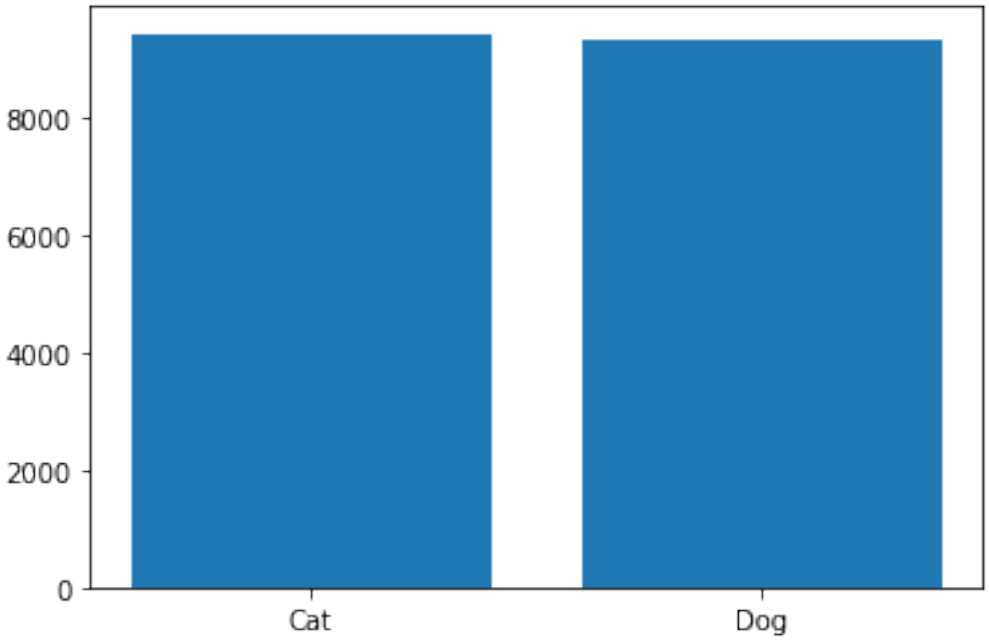
4 Target Classes Distribution and data set explaination

This data set has an 25,000 of pictures of cats and dogs in it **credit**: https://www.kaggle.com/c/dogs-vs-cats/data The model is supposed to be able to classify if an image has a cat in it or a dog in it. The images will not have both. The images will always have a cat or dog in it. There is roughly equal amount cat vs dog as shown in the graph below on the training data.

[86]:
```
num_classes = 2

@tf.function
def count_class(counts, batch):
    y, _, c = tf.unique_with_counts(batch[1])
    return tf.tensor_scatter_nd_add(counts, tf.expand_dims(y, axis=1), c)

counts = ds_pet_train.reduce(
    initial_state=tf.zeros(num_classes, tf.int32),
    reduce_func=count_class)

plt.bar(["Cat", "Dog"], counts.numpy())
print(counts.numpy())
```

```
Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9
Corrupt JPEG data: 228 extraneous bytes before marker 0xd9
Warning: unknown JFIF revision number 0.00
Corrupt JPEG data: 128 extraneous bytes before marker 0xd9
Corrupt JPEG data: 65 extraneous bytes before marker 0xd9
Corrupt JPEG data: 396 extraneous bytes before marker 0xd9
Corrupt JPEG data: 239 extraneous bytes before marker 0xd9
```

```
[9420 9308]
```



5 First Sequential model

This model is partly stolen from the kaggle the helped me set up this notebook. I changed the number of epochs from 3 to 10. I got rid of the convolution that was apart this model to let it be a basic sequential model.

Credit: https://www.kaggle.com/code/mauricioasperti/cats-vs-dogs-image-classification/notebook

[8]:
```
#Checking if the data format i.e the RGB channel is coming first or last so,␣
 ↪whatever it may be, model will check first and then input shape will be␣
 ↪feeded accordingly.
from keras import backend as K
if K.image_data_format() == "channels_first":
    input_shape = (3, img_height, img_width)
else:
    input_shape = (img_height, img_width, 3)

#Creating a model
sequential_model = Sequential([
  data_augmentation,
  layers.experimental.preprocessing.Rescaling(1./255,␣
 ↪input_shape=(input_shape)),
  layers.Dropout(0.5),
```

```
  layers.Flatten(),
  layers.Dense(128, activation="relu"),
  layers.Dense(1, activation="sigmoid")
])
```

[88]:
```
sequential_model.summary()
```

```
Model: "sequential_17"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
sequential_16 (Sequential)   (None, 180, 180, 3)       0
_________________________________________________________________
rescaling_15 (Rescaling)     (None, 180, 180, 3)       0
_________________________________________________________________
dropout_19 (Dropout)         (None, 180, 180, 3)       0
_________________________________________________________________
flatten_15 (Flatten)         (None, 97200)             0
_________________________________________________________________
dense_28 (Dense)             (None, 128)               12441728
_________________________________________________________________
dense_29 (Dense)             (None, 1)                 129
=================================================================
Total params: 12,441,857
Trainable params: 12,441,857
Non-trainable params: 0
_________________________________________________________________
```

[89]:
```
#Compiling the neural network
sequential_model.compile(optimizer="Adam", loss="binary_crossentropy",␣
 ↪metrics=["accuracy"])

#Fitting to the model
sequential_history = sequential_model.fit(ds_pet_train,␣
 ↪validation_data=ds_pet_test, epochs=10)
```

```
Epoch 1/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 2.8366 - accuracy:
0.5270

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 2.7120 - accuracy:
0.5271

Warning: unknown JFIF revision number 0.00
```

```
436/586 [=====================>…] - ETA: 15s - loss: 2.4343 - accuracy:
0.5302

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 14s - loss: 2.4080 - accuracy:
0.5309

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 13s - loss: 2.3781 - accuracy:
0.5310

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 2.3616 - accuracy:
0.5306

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 2.1649 - accuracy:
0.5304

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 66s 109ms/step - loss: 2.1652 -
accuracy: 0.5304 - val_loss: 1.1364 - val_accuracy: 0.5301
Epoch 2/10
  1/586 […] - ETA: 1:58 - loss: 1.3932 - accuracy:
0.4062

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 1.0049 - accuracy:
0.5444

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 1.0045 - accuracy:
0.5424

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 15s - loss: 0.9905 - accuracy:
0.5425

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 14s - loss: 0.9891 - accuracy:
0.5426

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9
```

```
457/586 [======================>…] - ETA: 13s - loss: 0.9857 - accuracy:
0.5434

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.9831 - accuracy:
0.5439

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.9730 - accuracy:
0.5434

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 109ms/step - loss: 0.9728 -
accuracy: 0.5435 - val_loss: 1.0725 - val_accuracy: 0.5117
Epoch 3/10
  1/586 […] - ETA: 2:00 - loss: 1.1729 - accuracy:
0.4688

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 0.7691 - accuracy:
0.5496

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

357/586 [=================>…] - ETA: 23s - loss: 0.7718 - accuracy:
0.5508

Warning: unknown JFIF revision number 0.00

436/586 [======================>…] - ETA: 15s - loss: 0.7635 - accuracy:
0.5509

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [======================>…] - ETA: 14s - loss: 0.7625 - accuracy:
0.5520

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 13s - loss: 0.7607 - accuracy:
0.5534

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.7597 - accuracy:
0.5532

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9
```

```
585/586 [============================>.] - ETA: 0s - loss: 0.7460 - accuracy:
0.5553

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 108ms/step - loss: 0.7459 -
accuracy: 0.5553 - val_loss: 0.6996 - val_accuracy: 0.5510
Epoch 4/10
  1/586 […] - ETA: 1:59 - loss: 0.6398 - accuracy:
0.5938

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 0.7009 - accuracy:
0.5551

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 0.6999 - accuracy:
0.5528

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 15s - loss: 0.6978 - accuracy:
0.5507

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [======================>…] - ETA: 14s - loss: 0.6977 - accuracy:
0.5506

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 13s - loss: 0.6974 - accuracy:
0.5511

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.6973 - accuracy:
0.5515

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.6948 - accuracy:
0.5532

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
```

```
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 109ms/step - loss: 0.6948 -
accuracy: 0.5531 - val_loss: 0.6812 - val_accuracy: 0.5944
Epoch 5/10
  1/586 […] - ETA: 2:05 - loss: 0.6735 - accuracy:
0.5938

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 0.6782 - accuracy:
0.5779

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

357/586 [=================>…] - ETA: 23s - loss: 0.6774 - accuracy:
0.5780

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 15s - loss: 0.6759 - accuracy:
0.5814

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [======================>…] - ETA: 14s - loss: 0.6756 - accuracy:
0.5820

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 13s - loss: 0.6757 - accuracy:
0.5816

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.6759 - accuracy:
0.5820

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [==============================>.] - ETA: 0s - loss: 0.6746 - accuracy:
0.5841

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 109ms/step - loss: 0.6746 -
accuracy: 0.5840 - val_loss: 0.6522 - val_accuracy: 0.6284
Epoch 6/10
  1/586 […] - ETA: 2:01 - loss: 0.6431 - accuracy:
0.6250
```

```
Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 0.6654 - accuracy:
0.5905

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 0.6667 - accuracy:
0.5873

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 15s - loss: 0.6683 - accuracy:
0.5823

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 14s - loss: 0.6684 - accuracy:
0.5822

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 13s - loss: 0.6688 - accuracy:
0.5816

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.6687 - accuracy:
0.5819

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.6687 - accuracy:
0.5824

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 109ms/step - loss: 0.6686 -
accuracy: 0.5824 - val_loss: 0.6552 - val_accuracy: 0.6200
Epoch 7/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 0.6627 - accuracy:
0.5905

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 0.6621 - accuracy:
0.5924

Warning: unknown JFIF revision number 0.00
```

```
436/586 [====================>…] - ETA: 15s - loss: 0.6621 - accuracy:
0.5923

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [====================>…] - ETA: 14s - loss: 0.6625 - accuracy:
0.5919

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [=====================>…] - ETA: 13s - loss: 0.6628 - accuracy:
0.5918

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [=====================>…] - ETA: 12s - loss: 0.6628 - accuracy:
0.5917

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.6619 - accuracy:
0.5935

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 109ms/step - loss: 0.6618 -
accuracy: 0.5935 - val_loss: 0.6393 - val_accuracy: 0.6341
Epoch 8/10
  1/586 […] - ETA: 1:56 - loss: 0.6682 - accuracy:
0.6250

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 0.6658 - accuracy:
0.5878

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 0.6638 - accuracy:
0.5916

Warning: unknown JFIF revision number 0.00

436/586 [====================>…] - ETA: 15s - loss: 0.6645 - accuracy:
0.5905

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [====================>…] - ETA: 14s - loss: 0.6646 - accuracy:
0.5900

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9
```

```
457/586 [======================>…] - ETA: 13s - loss: 0.6646 - accuracy:
0.5903

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.6646 - accuracy:
0.5896

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.6634 - accuracy:
0.5919

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 109ms/step - loss: 0.6634 -
accuracy: 0.5918 - val_loss: 0.6558 - val_accuracy: 0.6166
Epoch 9/10
  1/586 […] - ETA: 2:01 - loss: 0.6525 - accuracy:
0.5312

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 26s - loss: 0.6647 - accuracy:
0.5960

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 0.6636 - accuracy:
0.5974

Warning: unknown JFIF revision number 0.00

436/586 [======================>…] - ETA: 15s - loss: 0.6636 - accuracy:
0.5969

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [======================>…] - ETA: 14s - loss: 0.6640 - accuracy:
0.5961

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 13s - loss: 0.6648 - accuracy:
0.5958

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.6647 - accuracy:
0.5960

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9
```

```
585/586 [============================>.] - ETA: 0s - loss: 0.6645 - accuracy:
0.5961

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 64s 109ms/step - loss: 0.6645 -
accuracy: 0.5961 - val_loss: 0.6579 - val_accuracy: 0.6019
Epoch 10/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 27s - loss: 0.6655 - accuracy:
0.5926

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 23s - loss: 0.6640 - accuracy:
0.5958

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 15s - loss: 0.6662 - accuracy:
0.5937

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 14s - loss: 0.6661 - accuracy:
0.5942

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 13s - loss: 0.6661 - accuracy:
0.5937

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 12s - loss: 0.6662 - accuracy:
0.5938

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.6665 - accuracy:
0.5945

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9
```

```
586/586 [==============================] - 64s 109ms/step - loss: 0.6665 -
accuracy: 0.5945 - val_loss: 0.6499 - val_accuracy: 0.6070
```

6 RNN model

This model modifies the above Sequential model and adds the simple RNN layer.

[90]:
```
rnn_model = Sequential([
  data_augmentation,
  layers.experimental.preprocessing.Rescaling(1./255,␣
 ↪input_shape=(input_shape)),
  layers.Dropout(0.5),
  layers.Flatten(),
  layers.Dense(128, activation="relu"),
  layers.Dense(1, activation="sigmoid")
])
rnn_model.add(layers.Embedding(10000, 32))
rnn_model.add(layers.SimpleRNN(32))
```

[91]:
```
rnn_model.summary()
```

```
Model: "sequential_18"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
sequential_16 (Sequential)   (None, 180, 180, 3)       0
_________________________________________________________________
rescaling_16 (Rescaling)     (None, 180, 180, 3)       0
_________________________________________________________________
dropout_20 (Dropout)         (None, 180, 180, 3)       0
_________________________________________________________________
flatten_16 (Flatten)         (None, 97200)             0
_________________________________________________________________
dense_30 (Dense)             (None, 128)               12441728
_________________________________________________________________
dense_31 (Dense)             (None, 1)                 129
_________________________________________________________________
embedding_2 (Embedding)      (None, 1, 32)             320000
_________________________________________________________________
simple_rnn_3 (SimpleRNN)     (None, 32)                2080
=================================================================
Total params: 12,763,937
Trainable params: 12,763,937
Non-trainable params: 0
_________________________________________________________________
```

[92]:
```
#Compiling the neural network
rnn_model.compile(optimizer="Adam", loss="binary_crossentropy",␣
 ↪metrics=["accuracy"])

#Fitting to the model
rnn_history = rnn_model.fit(ds_pet_train, validation_data=ds_pet_test,␣
 ↪epochs=10)
```

```
Epoch 1/10
  1/586 […] - ETA: 15:23 - loss: 5.1574 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 23s - loss: 3.7467 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.7415 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 13s - loss: 3.6959 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 12s - loss: 3.6935 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 11s - loss: 3.6877 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 11s - loss: 3.6849 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.6656 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9
```

```
586/586 [==============================] - 58s 96ms/step - loss: 3.6653 -
accuracy: 0.0000e+00 - val_loss: 3.6062 - val_accuracy: 0.0000e+00
Epoch 2/10
  1/586 […] - ETA: 1:53 - loss: 3.9867 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 23s - loss: 3.5658 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.5645 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [====================>…] - ETA: 13s - loss: 3.5523 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [====================>…] - ETA: 12s - loss: 3.5458 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [=====================>…] - ETA: 11s - loss: 3.5406 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [=====================>…] - ETA: 11s - loss: 3.5405 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.5474 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 57s 96ms/step - loss: 3.5471 -
accuracy: 0.0000e+00 - val_loss: 3.5872 - val_accuracy: 0.0000e+00
Epoch 3/10
  1/586 […] - ETA: 1:50 - loss: 4.3536 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9
```

```
327/586 [===============>…] - ETA: 23s - loss: 3.5511 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.5516 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [====================>…] - ETA: 13s - loss: 3.5388 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

444/586 [====================>…] - ETA: 12s - loss: 3.5351 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [=====================>…] - ETA: 11s - loss: 3.5327 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [=====================>…] - ETA: 11s - loss: 3.5271 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.5387 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 96ms/step - loss: 3.5383 -
accuracy: 0.0000e+00 - val_loss: 3.5819 - val_accuracy: 0.0000e+00
Epoch 4/10
  1/586 […] - ETA: 1:48 - loss: 4.7390 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 23s - loss: 3.5407 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.5528 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00
```

```
436/586 [====================>…] - ETA: 13s - loss: 3.5351 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [====================>…] - ETA: 12s - loss: 3.5346 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [====================>…] - ETA: 11s - loss: 3.5260 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [====================>…] - ETA: 11s - loss: 3.5255 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.5337 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 96ms/step - loss: 3.5344 -
accuracy: 0.0000e+00 - val_loss: 3.5786 - val_accuracy: 0.0000e+00
Epoch 5/10
  1/586 […] - ETA: 1:50 - loss: 3.7485 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 23s - loss: 3.5396 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.5509 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [====================>…] - ETA: 13s - loss: 3.5318 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [====================>…] - ETA: 12s - loss: 3.5286 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9
```

```
457/586 [======================>…] - ETA: 11s - loss: 3.5279 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 10s - loss: 3.5274 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.5313 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 96ms/step - loss: 3.5316 -
accuracy: 0.0000e+00 - val_loss: 3.5761 - val_accuracy: 0.0000e+00
Epoch 6/10
  1/586 […] - ETA: 1:52 - loss: 2.9597 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 23s - loss: 3.5386 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.5427 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 13s - loss: 3.5342 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 12s - loss: 3.5283 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 11s - loss: 3.5210 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 10s - loss: 3.5206 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9
```

```
585/586 [============================>.] - ETA: 0s - loss: 3.5299 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 95ms/step - loss: 3.5296 -
accuracy: 0.0000e+00 - val_loss: 3.5743 - val_accuracy: 0.0000e+00
Epoch 7/10
  1/586 […] - ETA: 1:50 - loss: 4.1353 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 23s - loss: 3.5483 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.5416 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 13s - loss: 3.5312 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 12s - loss: 3.5262 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 11s - loss: 3.5220 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 11s - loss: 3.5207 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.5287 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
```

```
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 95ms/step - loss: 3.5280 -
accuracy: 0.0000e+00 - val_loss: 3.5730 - val_accuracy: 0.0000e+00
Epoch 8/10
  1/586 […] - ETA: 1:49 - loss: 3.3508 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [===============>…] - ETA: 23s - loss: 3.5328 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [=================>…] - ETA: 20s - loss: 3.5389 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [====================>…] - ETA: 13s - loss: 3.5284 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [====================>…] - ETA: 12s - loss: 3.5261 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [=====================>…] - ETA: 11s - loss: 3.5197 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [=====================>…] - ETA: 11s - loss: 3.5226 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [==============================>.] - ETA: 0s - loss: 3.5260 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 96ms/step - loss: 3.5270 -
accuracy: 0.0000e+00 - val_loss: 3.5722 - val_accuracy: 0.0000e+00
Epoch 9/10
  1/586 […] - ETA: 1:52 - loss: 3.7408 - accuracy:
0.0000e+00
```

```
Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [==============>…] - ETA: 23s - loss: 3.5376 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [================>…] - ETA: 20s - loss: 3.5426 - accuracy:
0.0000e+00

Warning: unknown JFIF revision number 0.00

436/586 [====================>…] - ETA: 13s - loss: 3.5264 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [====================>…] - ETA: 12s - loss: 3.5250 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [=====================>…] - ETA: 11s - loss: 3.5208 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [=====================>…] - ETA: 10s - loss: 3.5186 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.5265 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 96ms/step - loss: 3.5265 -
accuracy: 0.0000e+00 - val_loss: 3.5718 - val_accuracy: 0.0000e+00
Epoch 10/10
  1/586 […] - ETA: 1:51 - loss: 3.1552 - accuracy:
0.0000e+00

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

327/586 [==============>…] - ETA: 23s - loss: 3.5379 - accuracy:
0.0000e+00

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

358/586 [================>…] - ETA: 20s - loss: 3.5341 - accuracy:
0.0000e+00
```

```
Warning: unknown JFIF revision number 0.00

436/586 [=====================>…] - ETA: 13s - loss: 3.5221 - accuracy:
0.0000e+00

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

445/586 [=====================>…] - ETA: 12s - loss: 3.5243 - accuracy:
0.0000e+00

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

457/586 [======================>…] - ETA: 11s - loss: 3.5193 - accuracy:
0.0000e+00

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

464/586 [======================>…] - ETA: 10s - loss: 3.5171 - accuracy:
0.0000e+00

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 3.5262 - accuracy:
0.0000e+00

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 56s 95ms/step - loss: 3.5262 -
accuracy: 0.0000e+00 - val_loss: 3.5718 - val_accuracy: 0.0000e+00
```

7 CNN Model

This model is a combination of Professor mazidi's model in her github and the model from the aformentioned kaggle model. I added in convolution here for CNN.

Credit: https://github.com/kjmazidi/Machine_Learning_2nd_edition/blob/master/Part_7_Neural_Networks

[9]:
```
cnn_model = tf.keras.models.Sequential(
    [
        layers.experimental.preprocessing.Rescaling(1./255,␣
↪input_shape=(input_shape)),
        tf.keras.layers.Conv2D(32, kernel_size=(3, 3), activation="relu"),
        tf.keras.layers.MaxPooling2D(pool_size=(2, 2)),
        tf.keras.layers.Conv2D(64, kernel_size=(3, 3), activation="relu"),
        tf.keras.layers.MaxPooling2D(pool_size=(2, 2)),
        tf.keras.layers.Flatten(),
        tf.keras.layers.Dropout(0.5),
```

```
        tf.keras.layers.Dense(1, activation="sigmoid"),
    ]
)
```

[94]:
```
cnn_model.summary()
```

```
Model: "sequential_19"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
rescaling_17 (Rescaling)     (None, 180, 180, 3)       0
_________________________________________________________________
conv2d_26 (Conv2D)           (None, 178, 178, 32)      896
_________________________________________________________________
max_pooling2d_26 (MaxPooling (None, 89, 89, 32)        0
_________________________________________________________________
conv2d_27 (Conv2D)           (None, 87, 87, 64)        18496
_________________________________________________________________
max_pooling2d_27 (MaxPooling (None, 43, 43, 64)        0
_________________________________________________________________
flatten_17 (Flatten)         (None, 118336)            0
_________________________________________________________________
dropout_21 (Dropout)         (None, 118336)            0
_________________________________________________________________
dense_32 (Dense)             (None, 1)                 118337
=================================================================
Total params: 137,729
Trainable params: 137,729
Non-trainable params: 0
_________________________________________________________________
```

[10]:
```
cnn_model.compile(optimizer="Adam", loss="binary_crossentropy",␣
↪metrics=["accuracy"])

#Fitting to the model
cnn_history = cnn_model.fit(ds_pet_train, validation_data=ds_pet_test,␣
↪epochs=10)
```

```
Epoch 1/10

2022-12-05 05:30:50.129855: I
tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:185] None of the MLIR
Optimization Passes are enabled (registered 2)
Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9
2022-12-05 05:30:51.348870: I tensorflow/stream_executor/cuda/cuda_dnn.cc:369]
Loaded cuDNN version 8005

329/586 [===============>…] - ETA: 11s - loss: 0.6171 - accuracy:
```

```
0.6503

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 9s - loss: 0.6108 - accuracy:
0.6563

Warning: unknown JFIF revision number 0.00

439/586 [====================>…] - ETA: 6s - loss: 0.5985 - accuracy:
0.6679

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

449/586 [====================>…] - ETA: 5s - loss: 0.5976 - accuracy:
0.6691

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

461/586 [====================>…] - ETA: 5s - loss: 0.5969 - accuracy:
0.6709

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

467/586 [====================>…] - ETA: 5s - loss: 0.5958 - accuracy:
0.6718

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

586/586 [==============================] - ETA: 0s - loss: 0.5832 - accuracy:
0.6848

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 38s 52ms/step - loss: 0.5832 -
accuracy: 0.6848 - val_loss: 0.5370 - val_accuracy: 0.7386
Epoch 2/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 10s - loss: 0.4894 - accuracy:
0.7652

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

362/586 [=================>…] - ETA: 9s - loss: 0.4858 - accuracy:
0.7668

Warning: unknown JFIF revision number 0.00

440/586 [====================>…] - ETA: 6s - loss: 0.4802 - accuracy:
0.7705
```

```
Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

449/586 [=====================>…] - ETA: 5s - loss: 0.4797 - accuracy:
0.7707

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

461/586 [======================>…] - ETA: 5s - loss: 0.4785 - accuracy:
0.7714

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

467/586 [======================>…] - ETA: 4s - loss: 0.4789 - accuracy:
0.7713

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

583/586 [============================>.] - ETA: 0s - loss: 0.4783 - accuracy:
0.7711

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 30s 50ms/step - loss: 0.4786 -
accuracy: 0.7709 - val_loss: 0.4674 - val_accuracy: 0.7745
Epoch 3/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

331/586 [===============>…] - ETA: 10s - loss: 0.4241 - accuracy:
0.8083

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 9s - loss: 0.4228 - accuracy:
0.8089

Warning: unknown JFIF revision number 0.00

439/586 [=====================>…] - ETA: 6s - loss: 0.4188 - accuracy:
0.8103

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

449/586 [=====================>…] - ETA: 5s - loss: 0.4184 - accuracy:
0.8101

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

461/586 [======================>…] - ETA: 5s - loss: 0.4202 - accuracy:
0.8092

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9
```

```
467/586 [=====================>…] - ETA: 4s - loss: 0.4207 - accuracy:
0.8090

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

583/586 [============================>.] - ETA: 0s - loss: 0.4171 - accuracy:
0.8099

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 30s 50ms/step - loss: 0.4179 -
accuracy: 0.8093 - val_loss: 0.4409 - val_accuracy: 0.7950
Epoch 4/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 10s - loss: 0.3766 - accuracy:
0.8331

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

362/586 [=================>…] - ETA: 9s - loss: 0.3738 - accuracy:
0.8343

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 5s - loss: 0.3722 - accuracy:
0.8340

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.3715 - accuracy:
0.8345

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.3712 - accuracy:
0.8349

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 4s - loss: 0.3714 - accuracy:
0.8348

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.3674 - accuracy:
0.8375

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
```

```
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 29s 48ms/step - loss: 0.3674 -
accuracy: 0.8374 - val_loss: 0.4856 - val_accuracy: 0.7836
Epoch 5/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

331/586 [===============>…] - ETA: 9s - loss: 0.3287 - accuracy:
0.8573

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 8s - loss: 0.3251 - accuracy:
0.8590

Warning: unknown JFIF revision number 0.00

439/586 [=====================>…] - ETA: 5s - loss: 0.3218 - accuracy:
0.8597

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

449/586 [=====================>…] - ETA: 5s - loss: 0.3211 - accuracy:
0.8599

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

461/586 [======================>…] - ETA: 4s - loss: 0.3207 - accuracy:
0.8600

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

467/586 [======================>…] - ETA: 4s - loss: 0.3217 - accuracy:
0.8593

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

583/586 [============================>.] - ETA: 0s - loss: 0.3189 - accuracy:
0.8622

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 29s 49ms/step - loss: 0.3191 -
accuracy: 0.8622 - val_loss: 0.5142 - val_accuracy: 0.7785
Epoch 6/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9
```

```
330/586 [===============>…] - ETA: 9s - loss: 0.2885 - accuracy:
0.8786

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

362/586 [=================>…] - ETA: 8s - loss: 0.2869 - accuracy:
0.8784

Warning: unknown JFIF revision number 0.00

439/586 [====================>…] - ETA: 5s - loss: 0.2829 - accuracy:
0.8802

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

447/586 [====================>…] - ETA: 5s - loss: 0.2836 - accuracy:
0.8803

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

458/586 [=====================>…] - ETA: 5s - loss: 0.2839 - accuracy:
0.8801

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

466/586 [=====================>…] - ETA: 4s - loss: 0.2832 - accuracy:
0.8806

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

583/586 [============================>.] - ETA: 0s - loss: 0.2827 - accuracy:
0.8803

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 29s 48ms/step - loss: 0.2826 -
accuracy: 0.8804 - val_loss: 0.4765 - val_accuracy: 0.7909
Epoch 7/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 10s - loss: 0.2551 - accuracy:
0.8941

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

362/586 [=================>…] - ETA: 8s - loss: 0.2550 - accuracy:
0.8948

Warning: unknown JFIF revision number 0.00

440/586 [====================>…] - ETA: 5s - loss: 0.2514 - accuracy:
0.8957
```

```
Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.2524 - accuracy:
0.8954

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 4s - loss: 0.2529 - accuracy:
0.8948

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 4s - loss: 0.2532 - accuracy:
0.8952

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

583/586 [============================>.] - ETA: 0s - loss: 0.2508 - accuracy:
0.8963

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 29s 48ms/step - loss: 0.2508 -
accuracy: 0.8964 - val_loss: 0.5140 - val_accuracy: 0.7909
Epoch 8/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

331/586 [===============>…] - ETA: 9s - loss: 0.2259 - accuracy:
0.9062

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 8s - loss: 0.2258 - accuracy:
0.9063

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 5s - loss: 0.2207 - accuracy:
0.9088

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.2205 - accuracy:
0.9090

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 4s - loss: 0.2218 - accuracy:
0.9084

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9
```

```
468/586 [=====================>…] - ETA: 4s - loss: 0.2226 - accuracy:
0.9081

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

584/586 [============================>.] - ETA: 0s - loss: 0.2199 - accuracy:
0.9096

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 29s 49ms/step - loss: 0.2199 -
accuracy: 0.9095 - val_loss: 0.5739 - val_accuracy: 0.7841
Epoch 9/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

331/586 [===============>…] - ETA: 9s - loss: 0.2038 - accuracy:
0.9133

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

360/586 [=================>…] - ETA: 8s - loss: 0.2038 - accuracy:
0.9128

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 5s - loss: 0.2011 - accuracy:
0.9145

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.2010 - accuracy:
0.9148

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.2007 - accuracy:
0.9147

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 4s - loss: 0.2008 - accuracy:
0.9146

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

583/586 [============================>.] - ETA: 0s - loss: 0.2028 - accuracy:
0.9136

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
```

```
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 29s 48ms/step - loss: 0.2032 -
accuracy: 0.9134 - val_loss: 0.6322 - val_accuracy: 0.7747
Epoch 10/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

331/586 [===============>…] - ETA: 10s - loss: 0.1834 - accuracy:
0.9232

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 9s - loss: 0.1830 - accuracy:
0.9231

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 5s - loss: 0.1829 - accuracy:
0.9226

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.1830 - accuracy:
0.9223

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.1826 - accuracy:
0.9226

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 4s - loss: 0.1826 - accuracy:
0.9227

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

583/586 [============================>.] - ETA: 0s - loss: 0.1799 - accuracy:
0.9240

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 29s 48ms/step - loss: 0.1795 -
accuracy: 0.9242 - val_loss: 0.5834 - val_accuracy: 0.7864
```

8 Transfer Learning

This model follows the an example a Tensorflow Tutorial: https://www.tensorflow.org/tutorials/images/transfer_learning#data_preprocessing

I had no idea the example tutorial the professor supplied used a similar cats and dogs data set that I was using when I first started the assignment.

[11]:
```
base_model = tf.keras.applications.MobileNetV2(input_shape=input_shape,
                                               include_top=False,
                                               weights='imagenet')
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applicatio
ns/mobilenet_v2/mobilenet_v2_weights_tf_dim_ordering_tf_kernels_1.0_224_no_top.h
5
9412608/9406464 [==============================] - 0s 0us/step
9420800/9406464 [==============================] - 0s 0us/step
```

[12]:
```
image_batch, label_batch = next(iter(ds_pet_train))
feature_batch = base_model(image_batch)
print(feature_batch.shape)
```

```
Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9
```

```
(32, 6, 6, 1280)
```

[13]:
```
base_model.trainable = False
```

[14]:
```
base_model.summary()
```

```
Model: "mobilenetv2_1.00_224"
__________________________________________________________________________________
__________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================
==================
input_1 (InputLayer)            [(None, 180, 180, 3) 0
__________________________________________________________________________________
__________________
Conv1 (Conv2D)                  (None, 90, 90, 32)   864         input_1[0][0]
__________________________________________________________________________________
__________________
bn_Conv1 (BatchNormalization)   (None, 90, 90, 32)   128         Conv1[0][0]
__________________________________________________________________________________
__________________
Conv1_relu (ReLU)               (None, 90, 90, 32)   0           bn_Conv1[0][0]
__________________________________________________________________________________
__________________
expanded_conv_depthwise (Depthw (None, 90, 90, 32)   288
```

```
Conv1_relu[0][0]
__________________________________________________________________________________
__________________
expanded_conv_depthwise_BN (Bat (None, 90, 90, 32)   128
expanded_conv_depthwise[0][0]
__________________________________________________________________________________
__________________
expanded_conv_depthwise_relu (R (None, 90, 90, 32)   0
expanded_conv_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
expanded_conv_project (Conv2D)  (None, 90, 90, 16)   512
expanded_conv_depthwise_relu[0][0
__________________________________________________________________________________
__________________
expanded_conv_project_BN (Batch (None, 90, 90, 16)   64
expanded_conv_project[0][0]
__________________________________________________________________________________
__________________
block_1_expand (Conv2D)         (None, 90, 90, 96)   1536
expanded_conv_project_BN[0][0]
__________________________________________________________________________________
__________________
block_1_expand_BN (BatchNormali (None, 90, 90, 96)   384
block_1_expand[0][0]
__________________________________________________________________________________
__________________
block_1_expand_relu (ReLU)      (None, 90, 90, 96)   0
block_1_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_1_pad (ZeroPadding2D)     (None, 91, 91, 96)   0
block_1_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_1_depthwise (DepthwiseCon (None, 45, 45, 96)   864
block_1_pad[0][0]
__________________________________________________________________________________
__________________
block_1_depthwise_BN (BatchNorm (None, 45, 45, 96)   384
block_1_depthwise[0][0]
__________________________________________________________________________________
__________________
block_1_depthwise_relu (ReLU)   (None, 45, 45, 96)   0
block_1_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_1_project (Conv2D)        (None, 45, 45, 24)   2304
```

```
block_1_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_1_project_BN (BatchNormal (None, 45, 45, 24)   96
block_1_project[0][0]
__________________________________________________________________________________
__________________
block_2_expand (Conv2D)         (None, 45, 45, 144)  3456
block_1_project_BN[0][0]
__________________________________________________________________________________
__________________
block_2_expand_BN (BatchNormali (None, 45, 45, 144)  576
block_2_expand[0][0]
__________________________________________________________________________________
__________________
block_2_expand_relu (ReLU)      (None, 45, 45, 144)  0
block_2_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_2_depthwise (DepthwiseCon (None, 45, 45, 144)  1296
block_2_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_2_depthwise_BN (BatchNorm (None, 45, 45, 144)  576
block_2_depthwise[0][0]
__________________________________________________________________________________
__________________
block_2_depthwise_relu (ReLU)   (None, 45, 45, 144)  0
block_2_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_2_project (Conv2D)        (None, 45, 45, 24)   3456
block_2_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_2_project_BN (BatchNormal (None, 45, 45, 24)   96
block_2_project[0][0]
__________________________________________________________________________________
__________________
block_2_add (Add)               (None, 45, 45, 24)   0
block_1_project_BN[0][0]
block_2_project_BN[0][0]
__________________________________________________________________________________
__________________
block_3_expand (Conv2D)         (None, 45, 45, 144)  3456
block_2_add[0][0]
__________________________________________________________________________________
__________________
```

```
block_3_expand_BN (BatchNormali (None, 45, 45, 144)  576
block_3_expand[0][0]
__________________________________________________________________________________
__________________
block_3_expand_relu (ReLU)      (None, 45, 45, 144)  0
block_3_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_3_pad (ZeroPadding2D)     (None, 47, 47, 144)  0
block_3_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_3_depthwise (DepthwiseCon (None, 23, 23, 144)  1296
block_3_pad[0][0]
__________________________________________________________________________________
__________________
block_3_depthwise_BN (BatchNorm (None, 23, 23, 144)  576
block_3_depthwise[0][0]
__________________________________________________________________________________
__________________
block_3_depthwise_relu (ReLU)   (None, 23, 23, 144)  0
block_3_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_3_project (Conv2D)        (None, 23, 23, 32)   4608
block_3_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_3_project_BN (BatchNormal (None, 23, 23, 32)   128
block_3_project[0][0]
__________________________________________________________________________________
__________________
block_4_expand (Conv2D)         (None, 23, 23, 192)  6144
block_3_project_BN[0][0]
__________________________________________________________________________________
__________________
block_4_expand_BN (BatchNormali (None, 23, 23, 192)  768
block_4_expand[0][0]
__________________________________________________________________________________
__________________
block_4_expand_relu (ReLU)      (None, 23, 23, 192)  0
block_4_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_4_depthwise (DepthwiseCon (None, 23, 23, 192)  1728
block_4_expand_relu[0][0]
__________________________________________________________________________________
__________________
```

```
block_4_depthwise_BN (BatchNorm (None, 23, 23, 192)  768
block_4_depthwise[0][0]
__________________________________________________________________________________
__________________
block_4_depthwise_relu (ReLU)   (None, 23, 23, 192)  0
block_4_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_4_project (Conv2D)        (None, 23, 23, 32)   6144
block_4_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_4_project_BN (BatchNormal (None, 23, 23, 32)   128
block_4_project[0][0]
__________________________________________________________________________________
__________________
block_4_add (Add)               (None, 23, 23, 32)   0
block_3_project_BN[0][0]
block_4_project_BN[0][0]
__________________________________________________________________________________
__________________
block_5_expand (Conv2D)         (None, 23, 23, 192)  6144
block_4_add[0][0]
__________________________________________________________________________________
__________________
block_5_expand_BN (BatchNormali (None, 23, 23, 192)  768
block_5_expand[0][0]
__________________________________________________________________________________
__________________
block_5_expand_relu (ReLU)      (None, 23, 23, 192)  0
block_5_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_5_depthwise (DepthwiseCon (None, 23, 23, 192)  1728
block_5_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_5_depthwise_BN (BatchNorm (None, 23, 23, 192)  768
block_5_depthwise[0][0]
__________________________________________________________________________________
__________________
block_5_depthwise_relu (ReLU)   (None, 23, 23, 192)  0
block_5_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_5_project (Conv2D)        (None, 23, 23, 32)   6144
block_5_depthwise_relu[0][0]
__________________________________________________________________________________
```

```
------------------
block_5_project_BN (BatchNormal (None, 23, 23, 32)   128
block_5_project[0][0]
--------------------------------------------------------------------------------
------------------
block_5_add (Add)               (None, 23, 23, 32)   0
block_4_add[0][0]
block_5_project_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_6_expand (Conv2D)         (None, 23, 23, 192)  6144
block_5_add[0][0]
--------------------------------------------------------------------------------
------------------
block_6_expand_BN (BatchNormali (None, 23, 23, 192)  768
block_6_expand[0][0]
--------------------------------------------------------------------------------
------------------
block_6_expand_relu (ReLU)      (None, 23, 23, 192)  0
block_6_expand_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_6_pad (ZeroPadding2D)     (None, 25, 25, 192)  0
block_6_expand_relu[0][0]
--------------------------------------------------------------------------------
------------------
block_6_depthwise (DepthwiseCon (None, 12, 12, 192)  1728
block_6_pad[0][0]
--------------------------------------------------------------------------------
------------------
block_6_depthwise_BN (BatchNorm (None, 12, 12, 192)  768
block_6_depthwise[0][0]
--------------------------------------------------------------------------------
------------------
block_6_depthwise_relu (ReLU)   (None, 12, 12, 192)  0
block_6_depthwise_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_6_project (Conv2D)        (None, 12, 12, 64)   12288
block_6_depthwise_relu[0][0]
--------------------------------------------------------------------------------
------------------
block_6_project_BN (BatchNormal (None, 12, 12, 64)   256
block_6_project[0][0]
--------------------------------------------------------------------------------
------------------
block_7_expand (Conv2D)         (None, 12, 12, 384)  24576
block_6_project_BN[0][0]
```

```
----------------------------------------------------------------------------------------------------
block_7_expand_BN (BatchNormali (None, 12, 12, 384)  1536
block_7_expand[0][0]
----------------------------------------------------------------------------------------------------
block_7_expand_relu (ReLU)      (None, 12, 12, 384)  0
block_7_expand_BN[0][0]
----------------------------------------------------------------------------------------------------
block_7_depthwise (DepthwiseCon (None, 12, 12, 384)  3456
block_7_expand_relu[0][0]
----------------------------------------------------------------------------------------------------
block_7_depthwise_BN (BatchNorm (None, 12, 12, 384)  1536
block_7_depthwise[0][0]
----------------------------------------------------------------------------------------------------
block_7_depthwise_relu (ReLU)   (None, 12, 12, 384)  0
block_7_depthwise_BN[0][0]
----------------------------------------------------------------------------------------------------
block_7_project (Conv2D)        (None, 12, 12, 64)   24576
block_7_depthwise_relu[0][0]
----------------------------------------------------------------------------------------------------
block_7_project_BN (BatchNormal (None, 12, 12, 64)   256
block_7_project[0][0]
----------------------------------------------------------------------------------------------------
block_7_add (Add)               (None, 12, 12, 64)   0
block_6_project_BN[0][0]
block_7_project_BN[0][0]
----------------------------------------------------------------------------------------------------
block_8_expand (Conv2D)         (None, 12, 12, 384)  24576
block_7_add[0][0]
----------------------------------------------------------------------------------------------------
block_8_expand_BN (BatchNormali (None, 12, 12, 384)  1536
block_8_expand[0][0]
----------------------------------------------------------------------------------------------------
block_8_expand_relu (ReLU)      (None, 12, 12, 384)  0
block_8_expand_BN[0][0]
----------------------------------------------------------------------------------------------------
block_8_depthwise (DepthwiseCon (None, 12, 12, 384)  3456
```

```
block_8_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_8_depthwise_BN (BatchNorm (None, 12, 12, 384)  1536
block_8_depthwise[0][0]
__________________________________________________________________________________
__________________
block_8_depthwise_relu (ReLU)   (None, 12, 12, 384)  0
block_8_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_8_project (Conv2D)        (None, 12, 12, 64)   24576
block_8_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_8_project_BN (BatchNormal (None, 12, 12, 64)   256
block_8_project[0][0]
__________________________________________________________________________________
__________________
block_8_add (Add)               (None, 12, 12, 64)   0
block_7_add[0][0]
block_8_project_BN[0][0]
__________________________________________________________________________________
__________________
block_9_expand (Conv2D)         (None, 12, 12, 384)  24576
block_8_add[0][0]
__________________________________________________________________________________
__________________
block_9_expand_BN (BatchNormali (None, 12, 12, 384)  1536
block_9_expand[0][0]
__________________________________________________________________________________
__________________
block_9_expand_relu (ReLU)      (None, 12, 12, 384)  0
block_9_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_9_depthwise (DepthwiseCon (None, 12, 12, 384)  3456
block_9_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_9_depthwise_BN (BatchNorm (None, 12, 12, 384)  1536
block_9_depthwise[0][0]
__________________________________________________________________________________
__________________
block_9_depthwise_relu (ReLU)   (None, 12, 12, 384)  0
block_9_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
```

```
block_9_project (Conv2D)        (None, 12, 12, 64)   24576
block_9_depthwise_relu[0][0]
--------------------------------------------------------------------------------
------------------
block_9_project_BN (BatchNormal (None, 12, 12, 64)   256
block_9_project[0][0]
--------------------------------------------------------------------------------
------------------
block_9_add (Add)               (None, 12, 12, 64)   0
block_8_add[0][0]
block_9_project_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_10_expand (Conv2D)        (None, 12, 12, 384)  24576
block_9_add[0][0]
--------------------------------------------------------------------------------
------------------
block_10_expand_BN (BatchNormal (None, 12, 12, 384)  1536
block_10_expand[0][0]
--------------------------------------------------------------------------------
------------------
block_10_expand_relu (ReLU)     (None, 12, 12, 384)  0
block_10_expand_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_10_depthwise (DepthwiseCo (None, 12, 12, 384)  3456
block_10_expand_relu[0][0]
--------------------------------------------------------------------------------
------------------
block_10_depthwise_BN (BatchNor (None, 12, 12, 384)  1536
block_10_depthwise[0][0]
--------------------------------------------------------------------------------
------------------
block_10_depthwise_relu (ReLU)  (None, 12, 12, 384)  0
block_10_depthwise_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_10_project (Conv2D)       (None, 12, 12, 96)   36864
block_10_depthwise_relu[0][0]
--------------------------------------------------------------------------------
------------------
block_10_project_BN (BatchNorma (None, 12, 12, 96)   384
block_10_project[0][0]
--------------------------------------------------------------------------------
------------------
block_11_expand (Conv2D)        (None, 12, 12, 576)  55296
block_10_project_BN[0][0]
--------------------------------------------------------------------------------
```

```
------------------
block_11_expand_BN (BatchNormal (None, 12, 12, 576)  2304
block_11_expand[0][0]
--------------------------------------------------------------------------------
------------------
block_11_expand_relu (ReLU)     (None, 12, 12, 576)  0
block_11_expand_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_11_depthwise (DepthwiseCo (None, 12, 12, 576)  5184
block_11_expand_relu[0][0]
--------------------------------------------------------------------------------
------------------
block_11_depthwise_BN (BatchNor (None, 12, 12, 576)  2304
block_11_depthwise[0][0]
--------------------------------------------------------------------------------
------------------
block_11_depthwise_relu (ReLU)  (None, 12, 12, 576)  0
block_11_depthwise_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_11_project (Conv2D)       (None, 12, 12, 96)   55296
block_11_depthwise_relu[0][0]
--------------------------------------------------------------------------------
------------------
block_11_project_BN (BatchNorma (None, 12, 12, 96)   384
block_11_project[0][0]
--------------------------------------------------------------------------------
------------------
block_11_add (Add)              (None, 12, 12, 96)   0
block_10_project_BN[0][0]
block_11_project_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_12_expand (Conv2D)        (None, 12, 12, 576)  55296
block_11_add[0][0]
--------------------------------------------------------------------------------
------------------
block_12_expand_BN (BatchNormal (None, 12, 12, 576)  2304
block_12_expand[0][0]
--------------------------------------------------------------------------------
------------------
block_12_expand_relu (ReLU)     (None, 12, 12, 576)  0
block_12_expand_BN[0][0]
--------------------------------------------------------------------------------
------------------
block_12_depthwise (DepthwiseCo (None, 12, 12, 576)  5184
block_12_expand_relu[0][0]
```

```
__________________________________________________________________________________
__________________
block_12_depthwise_BN (BatchNor (None, 12, 12, 576)  2304
block_12_depthwise[0][0]
__________________________________________________________________________________
__________________
block_12_depthwise_relu (ReLU)  (None, 12, 12, 576)  0
block_12_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_12_project (Conv2D)       (None, 12, 12, 96)   55296
block_12_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_12_project_BN (BatchNorma (None, 12, 12, 96)   384
block_12_project[0][0]
__________________________________________________________________________________
__________________
block_12_add (Add)              (None, 12, 12, 96)   0
block_11_add[0][0]
block_12_project_BN[0][0]
__________________________________________________________________________________
__________________
block_13_expand (Conv2D)        (None, 12, 12, 576)  55296
block_12_add[0][0]
__________________________________________________________________________________
__________________
block_13_expand_BN (BatchNormal (None, 12, 12, 576)  2304
block_13_expand[0][0]
__________________________________________________________________________________
__________________
block_13_expand_relu (ReLU)     (None, 12, 12, 576)  0
block_13_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_13_pad (ZeroPadding2D)    (None, 13, 13, 576)  0
block_13_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_13_depthwise (DepthwiseCo (None, 6, 6, 576)    5184
block_13_pad[0][0]
__________________________________________________________________________________
__________________
block_13_depthwise_BN (BatchNor (None, 6, 6, 576)    2304
block_13_depthwise[0][0]
__________________________________________________________________________________
__________________
block_13_depthwise_relu (ReLU)  (None, 6, 6, 576)    0
```

```
block_13_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_13_project (Conv2D)       (None, 6, 6, 160)    92160
block_13_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_13_project_BN (BatchNorma (None, 6, 6, 160)    640
block_13_project[0][0]
__________________________________________________________________________________
__________________
block_14_expand (Conv2D)        (None, 6, 6, 960)    153600
block_13_project_BN[0][0]
__________________________________________________________________________________
__________________
block_14_expand_BN (BatchNormal (None, 6, 6, 960)    3840
block_14_expand[0][0]
__________________________________________________________________________________
__________________
block_14_expand_relu (ReLU)     (None, 6, 6, 960)    0
block_14_expand_BN[0][0]
__________________________________________________________________________________
__________________
block_14_depthwise (DepthwiseCo (None, 6, 6, 960)    8640
block_14_expand_relu[0][0]
__________________________________________________________________________________
__________________
block_14_depthwise_BN (BatchNor (None, 6, 6, 960)    3840
block_14_depthwise[0][0]
__________________________________________________________________________________
__________________
block_14_depthwise_relu (ReLU)  (None, 6, 6, 960)    0
block_14_depthwise_BN[0][0]
__________________________________________________________________________________
__________________
block_14_project (Conv2D)       (None, 6, 6, 160)    153600
block_14_depthwise_relu[0][0]
__________________________________________________________________________________
__________________
block_14_project_BN (BatchNorma (None, 6, 6, 160)    640
block_14_project[0][0]
__________________________________________________________________________________
__________________
block_14_add (Add)              (None, 6, 6, 160)    0
block_13_project_BN[0][0]
block_14_project_BN[0][0]
__________________________________________________________________________________
__________________
```

```
block_15_expand (Conv2D)        (None, 6, 6, 960)    153600
block_14_add[0][0]
------------------------------------------------------------------------------
------------------
block_15_expand_BN (BatchNormal (None, 6, 6, 960)    3840
block_15_expand[0][0]
------------------------------------------------------------------------------
------------------
block_15_expand_relu (ReLU)     (None, 6, 6, 960)    0
block_15_expand_BN[0][0]
------------------------------------------------------------------------------
------------------
block_15_depthwise (DepthwiseCo (None, 6, 6, 960)    8640
block_15_expand_relu[0][0]
------------------------------------------------------------------------------
------------------
block_15_depthwise_BN (BatchNor (None, 6, 6, 960)    3840
block_15_depthwise[0][0]
------------------------------------------------------------------------------
------------------
block_15_depthwise_relu (ReLU)  (None, 6, 6, 960)    0
block_15_depthwise_BN[0][0]
------------------------------------------------------------------------------
------------------
block_15_project (Conv2D)       (None, 6, 6, 160)    153600
block_15_depthwise_relu[0][0]
------------------------------------------------------------------------------
------------------
block_15_project_BN (BatchNorma (None, 6, 6, 160)    640
block_15_project[0][0]
------------------------------------------------------------------------------
------------------
block_15_add (Add)              (None, 6, 6, 160)    0
block_14_add[0][0]
block_15_project_BN[0][0]
------------------------------------------------------------------------------
------------------
block_16_expand (Conv2D)        (None, 6, 6, 960)    153600
block_15_add[0][0]
------------------------------------------------------------------------------
------------------
block_16_expand_BN (BatchNormal (None, 6, 6, 960)    3840
block_16_expand[0][0]
------------------------------------------------------------------------------
------------------
block_16_expand_relu (ReLU)     (None, 6, 6, 960)    0
block_16_expand_BN[0][0]
------------------------------------------------------------------------------
```

```
------------------
block_16_depthwise (DepthwiseCo (None, 6, 6, 960)    8640
block_16_expand_relu[0][0]
__________________________________________________________________________________
------------------
block_16_depthwise_BN (BatchNor (None, 6, 6, 960)    3840
block_16_depthwise[0][0]
__________________________________________________________________________________
------------------
block_16_depthwise_relu (ReLU)  (None, 6, 6, 960)    0
block_16_depthwise_BN[0][0]
__________________________________________________________________________________
------------------
block_16_project (Conv2D)       (None, 6, 6, 320)    307200
block_16_depthwise_relu[0][0]
__________________________________________________________________________________
------------------
block_16_project_BN (BatchNorma (None, 6, 6, 320)    1280
block_16_project[0][0]
__________________________________________________________________________________
------------------
Conv_1 (Conv2D)                 (None, 6, 6, 1280)   409600
block_16_project_BN[0][0]
__________________________________________________________________________________
------------------
Conv_1_bn (BatchNormalization)  (None, 6, 6, 1280)   5120        Conv_1[0][0]
__________________________________________________________________________________
------------------
out_relu (ReLU)                 (None, 6, 6, 1280)   0           Conv_1_bn[0][0]
==================================================================================
==================
Total params: 2,257,984
Trainable params: 0
Non-trainable params: 2,257,984
__________________________________________________________________________________
------------------
```

[15]:
```
global_average_layer = tf.keras.layers.GlobalAveragePooling2D()
feature_batch_average = global_average_layer(feature_batch)
print(feature_batch_average.shape)
```

```
(32, 1280)
```

[16]:
```
prediction_layer = tf.keras.layers.Dense(1)
prediction_batch = prediction_layer(feature_batch_average)
print(prediction_batch.shape)
```

```
(32, 1)
```

[17]:
```
preprocess_input = tf.keras.applications.mobilenet_v2.preprocess_input
inputs = tf.keras.Input(shape=input_shape)
x = data_augmentation(inputs)
x = preprocess_input(x)
x = base_model(x, training=False)
x = global_average_layer(x)
x = tf.keras.layers.Dropout(0.2)(x)
outputs = prediction_layer(x)
model = tf.keras.Model(inputs, outputs)
```

[18]:
```
base_learning_rate = 0.0001
model.compile(optimizer=tf.keras.optimizers.
 ↪Adam(learning_rate=base_learning_rate),
              loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
              metrics=['accuracy'])
```

[19]:
```
model.summary()
```

```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_2 (InputLayer)         [(None, 180, 180, 3)]     0
_________________________________________________________________
sequential (Sequential)      (None, 180, 180, 3)       0
_________________________________________________________________
tf.math.truediv (TFOpLambda) (None, 180, 180, 3)       0
_________________________________________________________________
tf.math.subtract (TFOpLambda (None, 180, 180, 3)       0
_________________________________________________________________
mobilenetv2_1.00_224 (Functi (None, 6, 6, 1280)        2257984
_________________________________________________________________
global_average_pooling2d (Gl (None, 1280)              0
_________________________________________________________________
dropout_2 (Dropout)          (None, 1280)              0
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 1281
=================================================================
Total params: 2,259,265
Trainable params: 1,281
Non-trainable params: 2,257,984
_________________________________________________________________
```

[20]:
```
loss0, accuracy0 = model.evaluate(ds_pet_test)
```

```
  2/147 […] - ETA: 7s - loss: 0.5469 - accuracy:
0.6406
```

```
Corrupt JPEG data: 252 extraneous bytes before marker 0xd9

 11/147 [=>…] - ETA: 5s - loss: 0.5811 - accuracy:
0.6250

Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9

 47/147 [========>…] - ETA: 4s - loss: 0.5773 - accuracy:
0.6543

Corrupt JPEG data: 162 extraneous bytes before marker 0xd9

 63/147 [===========>…] - ETA: 3s - loss: 0.5732 - accuracy:
0.6691

Corrupt JPEG data: 214 extraneous bytes before marker 0xd9

101/147 [====================>…] - ETA: 1s - loss: 0.5781 - accuracy:
0.6593

Corrupt JPEG data: 99 extraneous bytes before marker 0xd9

109/147 [=====================>…] - ETA: 1s - loss: 0.5756 - accuracy:
0.6614

Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

147/147 [==============================] - 8s 40ms/step - loss: 0.5829 -
accuracy: 0.6576
```

[21]:
```
transfer_history = model.fit(ds_pet_train, validation_data=ds_pet_test,␣
↪epochs=10)
```

```
Epoch 1/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

329/586 [===============>…] - ETA: 11s - loss: 0.3195 - accuracy:
0.8470

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 10s - loss: 0.3073 - accuracy:
0.8546

Warning: unknown JFIF revision number 0.00

438/586 [=====================>…] - ETA: 6s - loss: 0.2844 - accuracy:
0.8672

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 6s - loss: 0.2831 - accuracy:
0.8681

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9
```

```
460/586 [======================>…] - ETA: 5s - loss: 0.2795 - accuracy:
0.8702

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

466/586 [======================>…] - ETA: 5s - loss: 0.2783 - accuracy:
0.8708

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

586/586 [==============================] - ETA: 0s - loss: 0.2546 - accuracy:
0.8838

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 34s 54ms/step - loss: 0.2546 -
accuracy: 0.8838 - val_loss: 0.1076 - val_accuracy: 0.9579
Epoch 2/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 11s - loss: 0.1392 - accuracy:
0.9441

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

360/586 [=================>…] - ETA: 10s - loss: 0.1371 - accuracy:
0.9458

Warning: unknown JFIF revision number 0.00

440/586 [======================>…] - ETA: 6s - loss: 0.1346 - accuracy:
0.9462

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [======================>…] - ETA: 6s - loss: 0.1342 - accuracy:
0.9466

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.1332 - accuracy:
0.9469

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 5s - loss: 0.1330 - accuracy:
0.9470

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.1310 - accuracy:
0.9474
```

```
Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 32s 54ms/step - loss: 0.1310 -
accuracy: 0.9475 - val_loss: 0.0784 - val_accuracy: 0.9699
Epoch 3/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

329/586 [===============>…] - ETA: 11s - loss: 0.1147 - accuracy:
0.9550

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 9s - loss: 0.1121 - accuracy:
0.9559

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 6s - loss: 0.1110 - accuracy:
0.9561

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 6s - loss: 0.1104 - accuracy:
0.9564

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.1104 - accuracy:
0.9565

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 5s - loss: 0.1102 - accuracy:
0.9566

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.1091 - accuracy:
0.9569

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 32s 54ms/step - loss: 0.1091 -
accuracy: 0.9569 - val_loss: 0.0683 - val_accuracy: 0.9752
Epoch 4/10
```

```
Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 10s - loss: 0.1031 - accuracy:
0.9574

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

360/586 [=================>…] - ETA: 9s - loss: 0.1032 - accuracy:
0.9579

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 6s - loss: 0.0998 - accuracy:
0.9594

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.0999 - accuracy:
0.9593

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.0998 - accuracy:
0.9594

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 4s - loss: 0.0995 - accuracy:
0.9597

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.0991 - accuracy:
0.9598

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 31s 53ms/step - loss: 0.0991 -
accuracy: 0.9598 - val_loss: 0.0620 - val_accuracy: 0.9769
Epoch 5/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

329/586 [===============>…] - ETA: 11s - loss: 0.0984 - accuracy:
0.9599

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 9s - loss: 0.0975 - accuracy:
0.9604

Warning: unknown JFIF revision number 0.00
```

```
440/586 [=====================>…] - ETA: 6s - loss: 0.0966 - accuracy:
0.9603

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.0966 - accuracy:
0.9604

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.0963 - accuracy:
0.9606

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 5s - loss: 0.0962 - accuracy:
0.9606

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

585/586 [============================>.] - ETA: 0s - loss: 0.0960 - accuracy:
0.9607

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 32s 54ms/step - loss: 0.0961 -
accuracy: 0.9606 - val_loss: 0.0602 - val_accuracy: 0.9776
Epoch 6/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

331/586 [===============>…] - ETA: 10s - loss: 0.0971 - accuracy:
0.9596

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

360/586 [=================>…] - ETA: 9s - loss: 0.0965 - accuracy:
0.9599

Warning: unknown JFIF revision number 0.00

439/586 [=====================>…] - ETA: 6s - loss: 0.0947 - accuracy:
0.9608

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

449/586 [=====================>…] - ETA: 6s - loss: 0.0938 - accuracy:
0.9613

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

459/586 [======================>…] - ETA: 5s - loss: 0.0942 - accuracy:
0.9611
```

```
Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

467/586 [=====================>…] - ETA: 5s - loss: 0.0939 - accuracy:
0.9614

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

584/586 [============================>.] - ETA: 0s - loss: 0.0921 - accuracy:
0.9621

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 32s 54ms/step - loss: 0.0920 -
accuracy: 0.9622 - val_loss: 0.0573 - val_accuracy: 0.9797
Epoch 7/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

331/586 [===============>…] - ETA: 11s - loss: 0.0964 - accuracy:
0.9623

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

361/586 [=================>…] - ETA: 9s - loss: 0.0952 - accuracy:
0.9623

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 6s - loss: 0.0922 - accuracy:
0.9635

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 6s - loss: 0.0919 - accuracy:
0.9635

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.0914 - accuracy:
0.9636

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 5s - loss: 0.0913 - accuracy:
0.9637

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

584/586 [============================>.] - ETA: 0s - loss: 0.0896 - accuracy:
0.9634
```

```
Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 32s 54ms/step - loss: 0.0896 -
accuracy: 0.9633 - val_loss: 0.0555 - val_accuracy: 0.9801
Epoch 8/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 10s - loss: 0.0893 - accuracy:
0.9643

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

360/586 [=================>…] - ETA: 9s - loss: 0.0892 - accuracy:
0.9636

Warning: unknown JFIF revision number 0.00

440/586 [=====================>…] - ETA: 6s - loss: 0.0877 - accuracy:
0.9641

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

448/586 [=====================>…] - ETA: 5s - loss: 0.0872 - accuracy:
0.9644

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

460/586 [======================>…] - ETA: 5s - loss: 0.0869 - accuracy:
0.9645

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

468/586 [======================>…] - ETA: 4s - loss: 0.0867 - accuracy:
0.9646

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

586/586 [==============================] - ETA: 0s - loss: 0.0854 - accuracy:
0.9648

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 31s 53ms/step - loss: 0.0854 -
accuracy: 0.9648 - val_loss: 0.0539 - val_accuracy: 0.9812
Epoch 9/10
```

```
Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 11s - loss: 0.0913 - accuracy:
0.9629

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

360/586 [=================>…] - ETA: 9s - loss: 0.0907 - accuracy:
0.9630

Warning: unknown JFIF revision number 0.00

439/586 [=====================>…] - ETA: 6s - loss: 0.0903 - accuracy:
0.9633

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

449/586 [=====================>…] - ETA: 6s - loss: 0.0902 - accuracy:
0.9635

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

461/586 [======================>…] - ETA: 5s - loss: 0.0900 - accuracy:
0.9637

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

467/586 [======================>…] - ETA: 5s - loss: 0.0903 - accuracy:
0.9637

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

584/586 [============================>.] - ETA: 0s - loss: 0.0884 - accuracy:
0.9645

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 32s 54ms/step - loss: 0.0883 -
accuracy: 0.9645 - val_loss: 0.0532 - val_accuracy: 0.9810
Epoch 10/10

Corrupt JPEG data: 2226 extraneous bytes before marker 0xd9

330/586 [===============>…] - ETA: 10s - loss: 0.0870 - accuracy:
0.9652

Corrupt JPEG data: 228 extraneous bytes before marker 0xd9

360/586 [=================>…] - ETA: 9s - loss: 0.0859 - accuracy:
0.9655

Warning: unknown JFIF revision number 0.00
```

```
439/586 [=====================>…] - ETA: 6s - loss: 0.0834 - accuracy:
0.9667

Corrupt JPEG data: 128 extraneous bytes before marker 0xd9

449/586 [=====================>…] - ETA: 5s - loss: 0.0830 - accuracy:
0.9666

Corrupt JPEG data: 65 extraneous bytes before marker 0xd9

461/586 [=====================>…] - ETA: 5s - loss: 0.0826 - accuracy:
0.9669

Corrupt JPEG data: 396 extraneous bytes before marker 0xd9

467/586 [=====================>…] - ETA: 5s - loss: 0.0828 - accuracy:
0.9668

Corrupt JPEG data: 239 extraneous bytes before marker 0xd9

584/586 [============================>.] - ETA: 0s - loss: 0.0824 - accuracy:
0.9668

Corrupt JPEG data: 252 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1153 extraneous bytes before marker 0xd9
Corrupt JPEG data: 162 extraneous bytes before marker 0xd9
Corrupt JPEG data: 214 extraneous bytes before marker 0xd9
Corrupt JPEG data: 99 extraneous bytes before marker 0xd9
Corrupt JPEG data: 1403 extraneous bytes before marker 0xd9

586/586 [==============================] - 32s 53ms/step - loss: 0.0825 -
accuracy: 0.9667 - val_loss: 0.0518 - val_accuracy: 0.9816
```

9 Analysis

- Sequential:
- loss: 0.6665
- accuracy: 0.5945
- val_loss: 0.6499
- val_accuracy: 0.6070

The Sequential model a small margin better than a 50/50 coin toss. Meaning it likely was just guessing and was not really learning the necessary features to distinguish between a cat a dog. This is a difficult problem to overcome, especially because this dataset has roughly equal number of samples of cats and dogs. It is interesting to note that the validation accuracy was higher than the accuracy it self, this is a good thing in general becuase it means the model will generalize well. But in this case it might not mean much.

- RNN:
- loss: 3.5262
- accuracy: 0.0000e+00
- val_loss: 3.5718

- val_accuracy: 0.0000e+00

The RNN model did not work well at all. The less than 0.0000000 percent accuracy means that the model could not even guess correctly. I seem to think I may have done something wrong for such an abmissal accuracy rating. However, RNN's are not supposed to work well for image classifcation and maybe this is just an expression of how bad they are for it.

- CNN:
- loss: 0.1795
- accuracy: 0.9242
- val_loss: 0.5834
- val_accuracy: 0.7864

The CNN model worked relatively well. CNN is supposed to work well for image classification. It did have a much lower validation accuracy than the normal accuracy. So it will not generalize with the same 92% accuracy. But still a roughly 80% accuracy is not bad.

- Transfer Learning:
- loss: 0.0825
- accuracy: 0.9667
- val_loss: 0.0518
- val_accuracy: 0.9816

The Transfer Learning model worked extremely well with this data. The example was also using a cats and dogs dataset. I can only assume that the example cats and dogs dataset was probably a similar if not the same dataset I found. ImageNet is a powerful model that has been trained classify lots of pictures. So it is not surprise that a state of the art model can get such a high accuracy on such common dataset as cats vs dogs.