1. Imports

In [8]:
```
# ATTENTION: Please do not alter any of the provided code in the exercise. Or
# ATTENTION: Please do not add or remove any cells in the exercise. The grade
# ATTENTION: Please use the provided epoch values when training.

# In this exercise you will train a CNN on the FULL Cats-v-dogs dataset
# This will require you doing a lot of data preprocessing because
# the dataset isn't split into training and validation for you
# This code block has all the required inputs
import os
import zipfile
import random
import tensorflow as tf
import shutil
from tensorflow.keras.optimizers import RMSprop
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from shutil import copyfile
from os import getcwd
```

2. Extract files form working directory.

In [9]:
```
path_cats_and_dogs = f"{getcwd()}/../tmp2/cats-and-dogs.zip"
shutil.rmtree('/tmp')

local_zip = path_cats_and_dogs
zip_ref = zipfile.ZipFile(local_zip, 'r')
zip_ref.extractall('/tmp')
zip_ref.close()
```

3. Check the amount of Images in each file.

In [10]:
```
print(len(os.listdir('/tmp/PetImages/Cat/')))
print(len(os.listdir('/tmp/PetImages/Dog/')))

# Expected Output:
# 1500
# 1500
```

```
1500
1500
```

4. Create files for training and testing and within

those two files you have X amount of files where X| is the number of classes available for classification.

In [11]:
```
# Use os.mkdir to create your directories
# You will need a directory for cats-v-dogs, and subdirectories for training
# and testing. These in turn will need subdirectories for 'cats' and 'dogs'
try:
    os.mkdir('/tmp/cats-v-dogs')
    os.mkdir('/tmp/cats-v-dogs/training')
    os.mkdir('/tmp/cats-v-dogs/testing')
    os.mkdir('/tmp/cats-v-dogs/training/cats')
    os.mkdir('/tmp/cats-v-dogs/training/dogs')
    os.mkdir('/tmp/cats-v-dogs/testing/cats')
    os.mkdir('/tmp/cats-v-dogs/testing/dogs')
except OSError:
    pass
```

5. Splitting the data.

In [12]:

```
# Write a python function called split_data which takes
# a SOURCE directory containing the files
# a TRAINING directory that a portion of the files will be copied to
# a TESTING directory that a portion of the files will be copie to
# a SPLIT SIZE to determine the portion
# The files should also be randomized, so that the training set is a random
# X% of the files, and the test set is the remaining files
# SO, for example, if SOURCE is PetImages/Cat, and SPLIT SIZE is .9
# Then 90% of the images in PetImages/Cat will be copied to the TRAINING dir
# and 10% of the images will be copied to the TESTING dir
# Also -- All images should be checked, and if they have a zero file length,
# they will not be copied over
#
# os.listdir(DIRECTORY) gives you a listing of the contents of that directory
# os.path.getsize(PATH) gives you the size of the file
# copyfile(source, destination) copies a file from source to destination
# random.sample(list, len(list)) shuffles a list

def split_data(SOURCE, TRAINING, TESTING, SPLIT_SIZE):
    files = []
    for filename in os.listdir(SOURCE):
        file = SOURCE + filename
        if os.path.getsize(file) > 0:
            files.append(filename)
        else:
            print(filename + " is Empty")

    training_length = int(len(files) * SPLIT_SIZE)
    testing_length = int(len(files) - training_length)
    shuffled_set = random.sample(files, len(files))
    training_set = shuffled_set[0:training_length]
    testing_set = shuffled_set[:testing_length]

    for filename in training_set:
        this_file = SOURCE + filename
        destination = TRAINING + filename
        copyfile(this_file, destination)

    for filename in testing_set:
        this_file = SOURCE + filename
        destination = TESTING + filename
        copyfile(this_file, destination)

CAT_SOURCE_DIR = "/tmp/PetImages/Cat/"
TRAINING_CATS_DIR = "/tmp/cats-v-dogs/training/cats/"
TESTING_CATS_DIR = "/tmp/cats-v-dogs/testing/cats/"

DOG_SOURCE_DIR = "/tmp/PetImages/Dog/"
TRAINING_DOGS_DIR = "/tmp/cats-v-dogs/training/dogs/"
TESTING_DOGS_DIR = "/tmp/cats-v-dogs/testing/dogs/"

split_size = 0.9
split_data(CAT_SOURCE_DIR, TRAINING_CATS_DIR, TESTING_CATS_DIR, split_size)
split_data(DOG_SOURCE_DIR, TRAINING_DOGS_DIR, TESTING_DOGS_DIR, split_size)
```

6. Checking the results of the split.

In [13]:
```
print(len(os.listdir('/tmp/cats-v-dogs/training/cats/')))
print(len(os.listdir('/tmp/cats-v-dogs/training/dogs/')))
print(len(os.listdir('/tmp/cats-v-dogs/testing/cats/')))
print(len(os.listdir('/tmp/cats-v-dogs/testing/dogs/')))

# Expected output:
# 1350
# 1350
# 150
# 150
```

```
1350
1350
150
150
```

7. Creating the model.

In [25]:
```
# DEFINE A KERAS MODEL TO CLASSIFY CATS V DOGS
# USE AT LEAST 3 CONVOLUTION LAYERS
model = tf.keras.models.Sequential([
    # Note the input shape is the desired size of the image 150x150 with 3 by
    tf.keras.layers.Conv2D(16, (3,3), activation='relu', input_shape=(150, 15
    tf.keras.layers.MaxPooling2D(2,2),

    tf.keras.layers.Conv2D(32, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),

    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),

    # Flatten the results to feed into a DNN
    tf.keras.layers.Flatten(),

    # 128 neuron hidden layer
    tf.keras.layers.Dense(512, activation='relu'),


    # Only 1 output neuron. It will contain a value from 0-1 where 0 for 1 cl
    tf.keras.layers.Dense(1, activation='sigmoid')
])

model.compile(optimizer=RMSprop(lr=0.001), loss='binary_crossentropy', metric
```

In [26]:
```
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_6 (Conv2D)            (None, 148, 148, 16)      448
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 74, 74, 16)        0
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 72, 72, 32)        4640
_________________________________________________________________
max_pooling2d_7 (MaxPooling2 (None, 36, 36, 32)        0
_________________________________________________________________
conv2d_8 (Conv2D)            (None, 34, 34, 64)        18496
_________________________________________________________________
max_pooling2d_8 (MaxPooling2 (None, 17, 17, 64)        0
_________________________________________________________________
flatten_2 (Flatten)          (None, 18496)             0
_________________________________________________________________
dense_4 (Dense)              (None, 512)               9470464
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 513
=================================================================
Total params: 9,494,561
Trainable params: 9,494,561
Non-trainable params: 0
_________________________________________________________________
```

8. Auto Labeling using the generator.

NOTE:

In the cell below you **MUST** use a batch size of 10 (`batch_size=10`) for the `train_generator` and the `validation_generator` . Using a batch size greater than 10 will exceed memory limits on the Coursera platform.

In [27]:
```
TRAINING_DIR = "/tmp/cats-v-dogs/training"
# All images will be rescaled by 1./255.
train_datagen = ImageDataGenerator( rescale = 1.0/255. )
train_generator = train_datagen.flow_from_directory(TRAINING_DIR,
                                                    batch_size=10,
                                                    class_mode='binary',
                                                    target_size=(150, 150))

VALIDATION_DIR = "/tmp/cats-v-dogs/testing/"
# All images will be rescaled by 1./255.
validation_datagen = ImageDataGenerator( rescale = 1.0/255. )
# Flow validation images in batches of 10 using validation_datagen generator
validation_generator = validation_datagen.flow_from_directory(VALIDATION_DIR,
                                                              batch_size = 10,
                                                              class_mode  = 'b
                                                              target_size = (1




# Expected Output:
# Found 2700 images belonging to 2 classes.
# Found 300 images belonging to 2 classes.
```

```
Found 2700 images belonging to 2 classes.
Found 300 images belonging to 2 classes.
```

9. Fitting the model and storing it into a history variable.

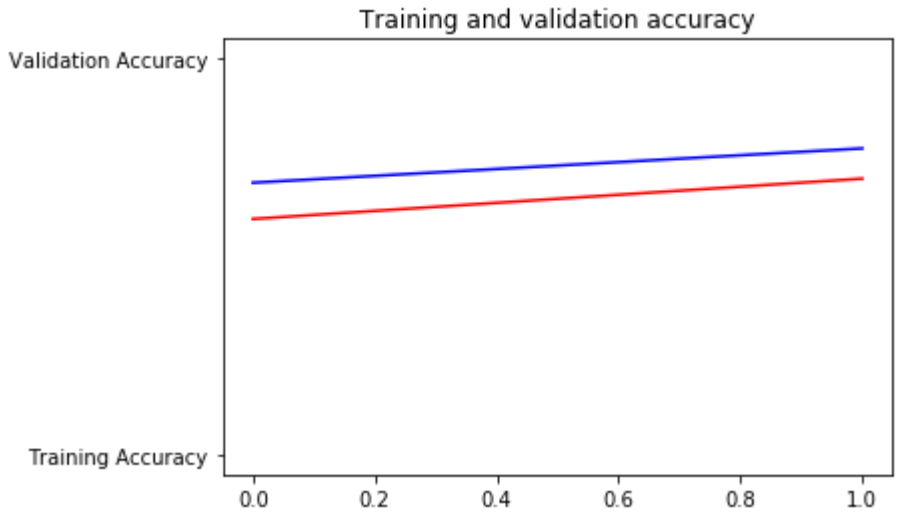
In [28]:
```
history = model.fit_generator(train_generator,
                              epochs=2,
                              verbose=1,
                              validation_data=validation_generator)
```

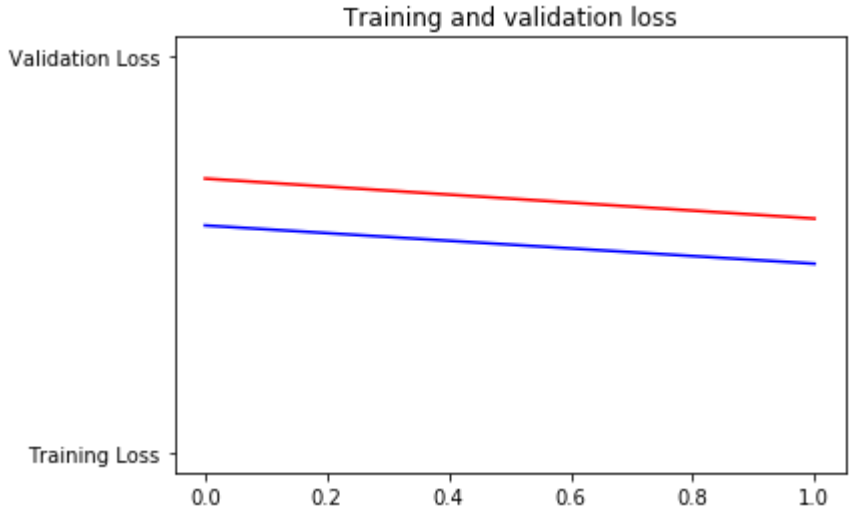
```
Epoch 1/2
270/270 [==============================] - 32s 120ms/step - loss: 0.6921 -
acc: 0.5952 - val_loss: 0.5737 - val_acc: 0.6867
Epoch 2/2
270/270 [==============================] - 31s 115ms/step - loss: 0.5911 -
acc: 0.6970 - val_loss: 0.4772 - val_acc: 0.7733
```

10 Model Analysis & visualization.

In [29]:
```
# PLOT LOSS AND ACCURACY
%matplotlib inline

import matplotlib.image  as mpimg
import matplotlib.pyplot as plt

#-----------------------------------------------------------
# Retrieve a list of list results on training and test data
# sets for each training epoch
#-----------------------------------------------------------
acc=history.history['acc']
val_acc=history.history['val_acc']
loss=history.history['loss']
val_loss=history.history['val_loss']


epochs=range(len(acc)) # Get number of epochs

#------------------------------------------------
# Plot training and validation accuracy per epoch
#------------------------------------------------
plt.plot(epochs, acc, 'r', "Training Accuracy")
plt.plot(epochs, val_acc, 'b', "Validation Accuracy")
plt.title('Training and validation accuracy')
plt.figure()

#------------------------------------------------
# Plot training and validation loss per epoch
#------------------------------------------------
plt.plot(epochs, loss, 'r', "Training Loss")
plt.plot(epochs, val_loss, 'b', "Validation Loss")


plt.title('Training and validation loss')

# Desired output. Charts with training and validation metrics. No crash :)
```

Out[29]:
```
Text(0.5, 1.0, 'Training and validation loss')
```





Submission Instructions

In [30]:
```
# Now click the 'Submit Assignment' button above.
```

When you're done or would like to take a break, please run the two cells below to save your work and close the Notebook. This will free up resources for your fellow learners.

In [31]:
```
%%javascript
<!-- Save the notebook -->
IPython.notebook.save_checkpoint();
```

In [ ]:
```
%%javascript
IPython.notebook.session.delete();
window.onbeforeunload = null
setTimeout(function() { window.close(); }, 1000);
```