Digital Image Processing Project

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This is the Project for CSE 314 - Digital Image Processing at SRM University, AP - Andhra Pradesh

The aim of this project is to classify the given new image of a conventional chest X - Ray into weather or not the lungs currosponding to the X Ray are infected with the pneonomia sue to coronavirus or not.

In [2]:

```
# Importing Libraries
import tensorflow as tf

from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Conv2D, Flatten, Dropout, MaxPooling2
D
from tensorflow.keras.preprocessing.image import ImageDataGenerator

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

In [3]:

```
!ls
```

```
COVID-classifier.ipynb DataSet
```

In [4]:

```
PATH = 'DataSet'
```

In [5]:

```
os.path
```

Out[5]:

```
<module 'posixpath' from '/Users/miranjunaidi/opt/anaconda3/envs/wor
k/lib/python3.7/posixpath.py'>
```

In [6]:

```
num_cats_tr = len(os.listdir(PATH))
```

In [7]:

```
num_cats_tr
```

Out[7]:

```
3
```

In [8]:

```
temp = os.path.join(PATH , 'Train')
```

In [9]:

```
temp
```

Out[9]:

```
'DataSet/Train'
```

In [10]:

```
num_cats_tr = len(os.listdir(PATH))
```

In [11]:

```
num_cats_tr
```

Out[11]:

```
3
```

In [12]:

```
temp = os.path.join(temp , 'Train')
```

In [13]:

```
temp
```

Out[13]:

```
'DataSet/Train/Train'
```

In [14]:

```
num_cats_tr = len(os.listdir(PATH))
```

In [15]:

```
num_cats_tr
```

Out[15]:

```
3
```

In [16]:

```
path_to_zip = tf.keras.utils.get_file?
```

```
Signature:
tf.keras.utils.get_file(
    fname,
    origin,
    untar=False,
    md5_hash=None,
    file_hash=None,
    cache_subdir='datasets',
    hash_algorithm='auto',
    extract=False,
    archive_format='auto',
    cache_dir=None,
)
Docstring:
Downloads a file from a URL if it not already in the cache.

By default the file at the url `origin` is downloaded to the
cache_dir `~/.keras`, placed in the cache_subdir `datasets`,
and given the filename `fname`. The final location of a file
`example.txt` would therefore be `~/.keras/datasets/example.txt`.

Files in tar, tar.gz, tar.bz, and zip formats can also be extracted.
Passing a hash will verify the file after download. The command line
programs `shasum` and `sha256sum` can compute the hash.

Arguments:
    fname: Name of the file. If an absolute path `/path/to/file.txt`
is
        specified the file will be saved at that location.
    origin: Original URL of the file.
    untar: Deprecated in favor of 'extract'.
        boolean, whether the file should be decompressed
    md5_hash: Deprecated in favor of 'file_hash'.
        md5 hash of the file for verification
    file_hash: The expected hash string of the file after download.
        The sha256 and md5 hash algorithms are both supported.
    cache_subdir: Subdirectory under the Keras cache dir where the f
ile is
        saved. If an absolute path `/path/to/folder` is
        specified the file will be saved at that location.
    hash_algorithm: Select the hash algorithm to verify the file.
        options are 'md5', 'sha256', and 'auto'.
        The default 'auto' detects the hash algorithm in use.
    extract: True tries extracting the file as an Archive, like tar
 or zip.
    archive_format: Archive format to try for extracting the file.
        Options are 'auto', 'tar', 'zip', and None.
        'tar' includes tar, tar.gz, and tar.bz files.
        The default 'auto' is ['tar', 'zip'].
        None or an empty list will return no matches found.
    cache_dir: Location to store cached files, when None it
        defaults to the [Keras
          Directory](/faq/#where-is-the-keras-configuration-filed-st
ored).

Returns:
    Path to the downloaded file
File:      ~/opt/anaconda3/envs/work/lib/python3.7/site-packages/ten
sorflow_core/python/keras/utils/data_utils.py
Type:      function
```

In [ ]:

```
path_to_zip = tf.keras.utils.get_file
```

In [17]:

```
path_to_zip = tf.keras.utils.get_file
```

In [18]:

```
_URL = 'https://storage.googleapis.com/mledu-datasets/cats_and_dogs_filtered.zi
p'

path_to_zip = tf.keras.utils.get_file('cats_and_dogs.zip', origin=_URL, extract=
True)

PATH = os.path.join(os.path.dirname(path_to_zip), 'cats_and_dogs_filtered')
```

In [19]:

```
PATH
```

Out[19]:

```
'/Users/miranjunaidi/.keras/datasets/cats_and_dogs_filtered'
```

In [29]:

```
PATH = "/Users/miranjunaidi/Documents/6thSem/DIP/DIP_Project/MyProject"
```

In [30]:

```
PATH = os.path.join(PATH , 'DataSet')
```

In [31]:

```
num_cats_tr = len(os.listdir(PATH))
```

In [32]:

```
num_cats_tr
```

Out[32]:

```
3
```

In [33]:

```
PATH
```

Out[33]:

```
'/Users/miranjunaidi/Documents/6thSem/DIP/DIP_Project/MyProject/Data
Set'
```

In [34]:

```
PATH = os.path.join(PATH , 'Train')
```

In [39]:

```
temp = os.listdir(PATH)
```

In [40]:

```
temp
```

Out[40]:

```
['.DS_Store', 'NON-COVID', 'COVID']
```

In [41]:

```
PATH = os.path.join(PATH , 'NON-COVID')
```

In [42]:

```
num_cats_tr = len(os.listdir(PATH))
```

In [43]:

```
num_cats_tr
```

Out[43]:

```
150
```

In [44]:

```
PATH = "/Users/miranjunaidi/Documents/6thSem/DIP/DIP_Project/MyProject"
```

In [45]:

```
PATH = os.path.join(PATH , 'DataSet')
```

In [46]:

```
os.listdir(PATH)
```

Out[46]:

```
['.DS_Store', 'Train', 'Test ']
```

Figured the Path and structured the directories. PATH is the path to the Dataset

In [48]:

```
train_dir = os.path.join(PATH, 'Train')
test_dir = os.path.join(PATH, 'Test')
```

In [64]:

```
train_covid_dir = os.path.join(train_dir, 'COVID')  # directory with our training Covid
train_non_covid_dir = os.path.join(train_dir, 'NON-COVID')  # directory with our training Non covid
test_covid_dir = os.path.join(test_dir, 'Covid')  # directory with our test Coid
test_noncovid_dir = os.path.join(test_dir, 'NONCovid')  # directory with our test for non-covid
```

In [65]:

```
num_covid_images = len(os.listdir(train_covid_dir))
num_non_covid_images = len(os.listdir(train_non_covid_dir))
```

In [66]:

```
num_covid_images
```

Out[66]:

```
150
```

In [67]:

```
num_non_covid_images
```

Out[67]:

```
150
```

In [72]:

```
num_covid_test = len(os.listdir(test_covid_dir))
num_noncovid_test = len(os.listdir(test_noncovid_dir))
```

In [69]:

```
num_covid_test
```

Out[69]:

```
50
```

In [73]:

```
num_noncovid_test
```

Out[73]:

```
50
```

In [74]:

```
os.listdir(test_noncovid_dir)
```

Out[74]:

```
['NORMAL2-IM-0102-0001.jpeg',
 'NORMAL2-IM-0027-0001.jpeg',
 'NORMAL2-IM-0033-0001.jpeg',
 'NORMAL2-IM-0012-0001.jpeg',
 'NORMAL2-IM-0019-0001.jpeg',
 'IM-0084-0001.jpeg',
 'IM-0089-0001.jpeg',
 'NORMAL2-IM-0092-0001.jpeg',
 'NORMAL2-IM-0086-0001.jpeg',
 'NORMAL2-IM-0035-0001.jpeg',
 'IM-0097-0001.jpeg',
 'NORMAL2-IM-0045-0001.jpeg',
 'NORMAL2-IM-0051-0001.jpeg',
 'NORMAL2-IM-0098-0001.jpeg',
 'IM-0083-0001.jpeg',
 'NORMAL2-IM-0081-0001.jpeg',
 'IM-0101-0001.jpeg',
 'NORMAL2-IM-0095-0001.jpeg',
 'NORMAL2-IM-0007-0001.jpeg',
 'NORMAL2-IM-0013-0001.jpeg',
 'IM-0091-0001.jpeg',
 'NORMAL2-IM-0105-0001.jpeg',
 'IM-0085-0001.jpeg',
 'IM-0107-0001.jpeg',
 'NORMAL2-IM-0073-0001.jpeg',
 'NORMAL2-IM-0052-0001.jpeg',
 'NORMAL2-IM-0028-0001.jpeg',
 'NORMAL2-IM-0096-0001.jpeg',
 'IM-0102-0001.jpeg',
 'IM-0099-0001.jpeg',
 'IM-0086-0001.jpeg',
 'IM-0109-0001.jpeg',
 'NORMAL2-IM-0023-0001.jpeg',
 'NORMAL2-IM-0059-0001.jpeg',
 'IM-0110-0001.jpeg',
 'NORMAL2-IM-0072-0001.jpeg',
 'NORMAL2-IM-0066-0001.jpeg',
 'IM-0095-0001.jpeg',
 'NORMAL2-IM-0029-0001.jpeg',
 'NORMAL2-IM-0030-0001.jpeg',
 'IM-0103-0001.jpeg',
 'NORMAL2-IM-0041-0001.jpeg',
 'NORMAL2-IM-0107-0001.jpeg',
 'IM-0093-0001.jpeg',
 'IM-0087-0001.jpeg',
 'NORMAL2-IM-0060-0001.jpeg',
 'IM-0111-0001.jpeg',
 'NORMAL2-IM-0058-0001.jpeg',
 'IM-0105-0001.jpeg',
 'NORMAL2-IM-0079-0001.jpeg']
```

In [75]:

```
total_train = num_covid_images + num_non_covid_images
total_test = num_covid_test + num_noncovid_test
```

In [76]:

```
print('total training Covid images:', num_covid_images)
print('total training Non-Covid images:', num_non_covid_images)

print('total Testing Covid images:', num_covid_test)
print('total Testing Non-Covid images:', num_noncovid_test)
print("--")
print("Total training images:", total_train)
print("Total Testing images:", total_test)
```

```
total training Covid images: 150
total training Non-Covid images: 150
total Testing Covid images: 50
total Testing Non-Covid images: 50
--
Total training images: 300
Total Testing images: 100
```

In [92]:

```
batch_size = 10
epochs = 15
IMG_HEIGHT = 150
IMG_WIDTH = 150
```

In [93]:

```
train_image_generator = ImageDataGenerator(rescale=1./255) # Generator for our t
raining data
validation_image_generator = ImageDataGenerator(rescale=1./255) # Generator for
 our validation data
```

In [94]:

```
train_data_gen = train_image_generator.flow_from_directory(batch_size=batch_size
,
                                                           directory=train_dir,
                                                           shuffle=True,
                                                           target_size=(IMG_HEIG
HT, IMG_WIDTH),
                                                           class_mode='binary')
```

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

In [95]:

```
test_data_gen = validation_image_generator.flow_from_directory(batch_size=batch_
size,
                                                               directory=test_dir
,
                                                               target_size=(IMG_H
EIGHT, IMG_WIDTH),
                                                               class_mode='binar
y')
```

```
Found 100 images belonging to 2 classes.
```

In [96]:

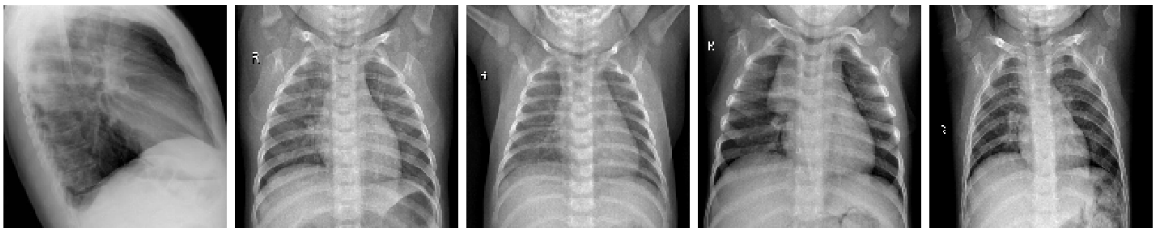
```
sample_training_images, _ = next(train_data_gen)
```

In [97]:

```
def plotImages(images_arr):
    fig, axes = plt.subplots(1, 5, figsize=(20,20))
    axes = axes.flatten()
    for img, ax in zip( images_arr, axes):
        ax.imshow(img)
        ax.axis('off')
    plt.tight_layout()
    plt.show()
```

In [98]:

```
plotImages(sample_training_images[:5])
```



In [99]:

```
model = Sequential([
    Conv2D(16, 3, padding='same', activation='relu', input_shape=(IMG_HEIGHT, IM
G_WIDTH ,3)),
    MaxPooling2D(),
    Conv2D(32, 3, padding='same', activation='relu'),
    MaxPooling2D(),
    Conv2D(64, 3, padding='same', activation='relu'),
    MaxPooling2D(),
    Flatten(),
    Dense(512, activation='relu'),
    Dense(1)
])
```

In [100]:

```
model.compile(optimizer='adam',
              loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
              metrics=['accuracy'])
```

In [101]:

```
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d_6 (Conv2D)            (None, 150, 150, 16)      448       
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 75, 75, 16)        0         
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 75, 75, 32)        4640      
_________________________________________________________________
max_pooling2d_7 (MaxPooling2 (None, 37, 37, 32)        0         
_________________________________________________________________
conv2d_8 (Conv2D)            (None, 37, 37, 64)        18496     
_________________________________________________________________
max_pooling2d_8 (MaxPooling2 (None, 18, 18, 64)        0         
_________________________________________________________________
flatten_2 (Flatten)          (None, 20736)             0         
_________________________________________________________________
dense_4 (Dense)              (None, 512)               10617344  
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 513       
=================================================================
Total params: 10,641,441
Trainable params: 10,641,441
Non-trainable params: 0
_________________________________________________________________
```

In [102]:

```
history = model.fit_generator(
    train_data_gen,
    steps_per_epoch=total_train // batch_size,
    epochs=epochs,
    validation_data=test_data_gen,
    validation_steps=total_test // batch_size
)
```

```
Epoch 1/15
29/30 [============================>.] - ETA: 0s - loss: 0.4820 - ac
c: 0.7310Epoch 1/15
30/30 [==============================] - 25s 847ms/step - loss: 0.46
77 - acc: 0.7367 - val_loss: 0.1251 - val_acc: 0.9700
Epoch 2/15
29/30 [============================>.] - ETA: 0s - loss: 0.1717 - ac
c: 0.9621Epoch 1/15
30/30 [==============================] - 25s 844ms/step - loss: 0.16
66 - acc: 0.9633 - val_loss: 0.9109 - val_acc: 0.7100
Epoch 3/15
29/30 [============================>.] - ETA: 0s - loss: 0.0695 - ac
c: 0.9724Epoch 1/15
30/30 [==============================] - 26s 871ms/step - loss: 0.06
79 - acc: 0.9733 - val_loss: 0.0831 - val_acc: 0.9500
Epoch 4/15
29/30 [============================>.] - ETA: 0s - loss: 0.0520 - ac
c: 0.9828Epoch 1/15
30/30 [==============================] - 20s 652ms/step - loss: 0.05
05 - acc: 0.9833 - val_loss: 0.3622 - val_acc: 0.8200
Epoch 5/15
29/30 [============================>.] - ETA: 0s - loss: 0.0103 - ac
c: 0.9931Epoch 1/15
30/30 [==============================] - 20s 661ms/step - loss: 0.00
99 - acc: 0.9933 - val_loss: 0.2033 - val_acc: 0.9200
Epoch 6/15
29/30 [============================>.] - ETA: 0s - loss: 8.0299e-04
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 22s 723ms/step - loss: 7.77
13e-04 - acc: 1.0000 - val_loss: 0.1168 - val_acc: 0.9300
Epoch 7/15
29/30 [============================>.] - ETA: 0s - loss: 4.1519e-04
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 19s 633ms/step - loss: 5.03
57e-04 - acc: 1.0000 - val_loss: 0.2440 - val_acc: 0.9200
Epoch 8/15
29/30 [============================>.] - ETA: 0s - loss: 1.0772e-04
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 18s 607ms/step - loss: 1.66
48e-04 - acc: 1.0000 - val_loss: 0.1786 - val_acc: 0.9100
Epoch 9/15
29/30 [============================>.] - ETA: 0s - loss: 8.0399e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 18s 591ms/step - loss: 8.23
28e-05 - acc: 1.0000 - val_loss: 0.2559 - val_acc: 0.9200
Epoch 10/15
29/30 [============================>.] - ETA: 0s - loss: 4.4776e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 18s 594ms/step - loss: 4.33
10e-05 - acc: 1.0000 - val_loss: 0.2485 - val_acc: 0.9200
Epoch 11/15
29/30 [============================>.] - ETA: 0s - loss: 3.4833e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 22s 739ms/step - loss: 3.36
73e-05 - acc: 1.0000 - val_loss: 0.2520 - val_acc: 0.9200
Epoch 12/15
29/30 [============================>.] - ETA: 0s - loss: 2.8948e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 28s 931ms/step - loss: 2.80
74e-05 - acc: 1.0000 - val_loss: 0.2520 - val_acc: 0.9200
Epoch 13/15
```

```
29/30 [============================>.] - ETA: 0s - loss: 2.6100e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 25s 825ms/step - loss: 2.54
43e-05 - acc: 1.0000 - val_loss: 0.2656 - val_acc: 0.9200
Epoch 14/15
29/30 [============================>.] - ETA: 0s - loss: 2.2265e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 20s 658ms/step - loss: 2.15
64e-05 - acc: 1.0000 - val_loss: 0.2582 - val_acc: 0.9200
Epoch 15/15
29/30 [============================>.] - ETA: 0s - loss: 1.9835e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 24s 785ms/step - loss: 1.94
67e-05 - acc: 1.0000 - val_loss: 0.2512 - val_acc: 0.9200
```

In [107]:

```
history.history
```

Out[107]:

```
{'loss': [0.46765277137358985,
  0.16659826613031328,
  0.06789930345645795,
  0.05054639279042021,
  0.009926372185448902,
  0.0007771310181321193,
  0.0005035689053158876,
  0.00016647607425426258,
  8.232782930311563e-05,
  4.330988141039901e-05,
  3.36725873769872e-05,
  2.807432358788257e-05,
  2.5442967909938828e-05,
  2.156381653080075e-05,
  1.946665426977671e-05],
 'acc': [0.7366667,
  0.9633333,
  0.97333336,
  0.98333335,
  0.99333334,
  1.0,
  1.0,
  1.0,
  1.0,
  1.0,
  1.0,
  1.0,
  1.0,
  1.0,
  1.0],
 'val_loss': [0.12507312661036848,
  0.9109101890120656,
  0.08314864123240114,
  0.36220331299118697,
  0.20333826141431927,
  0.11682728130326722,
  0.24400449512831984,
  0.17857444066576136,
  0.25586579729679215,
  0.24849737929471302,
  0.2520318753194715,
  0.2519814725412289,
  0.26563949900096306,
  0.25817560504474385,
  0.25124409367272166],
 'val_acc': [0.97,
  0.71,
  0.95,
  0.82,
  0.92,
  0.93,
  0.92,
  0.91,
  0.92,
  0.92,
  0.92,
  0.92,
  0.92,
  0.92,
  0.92]}
```

In [109]:

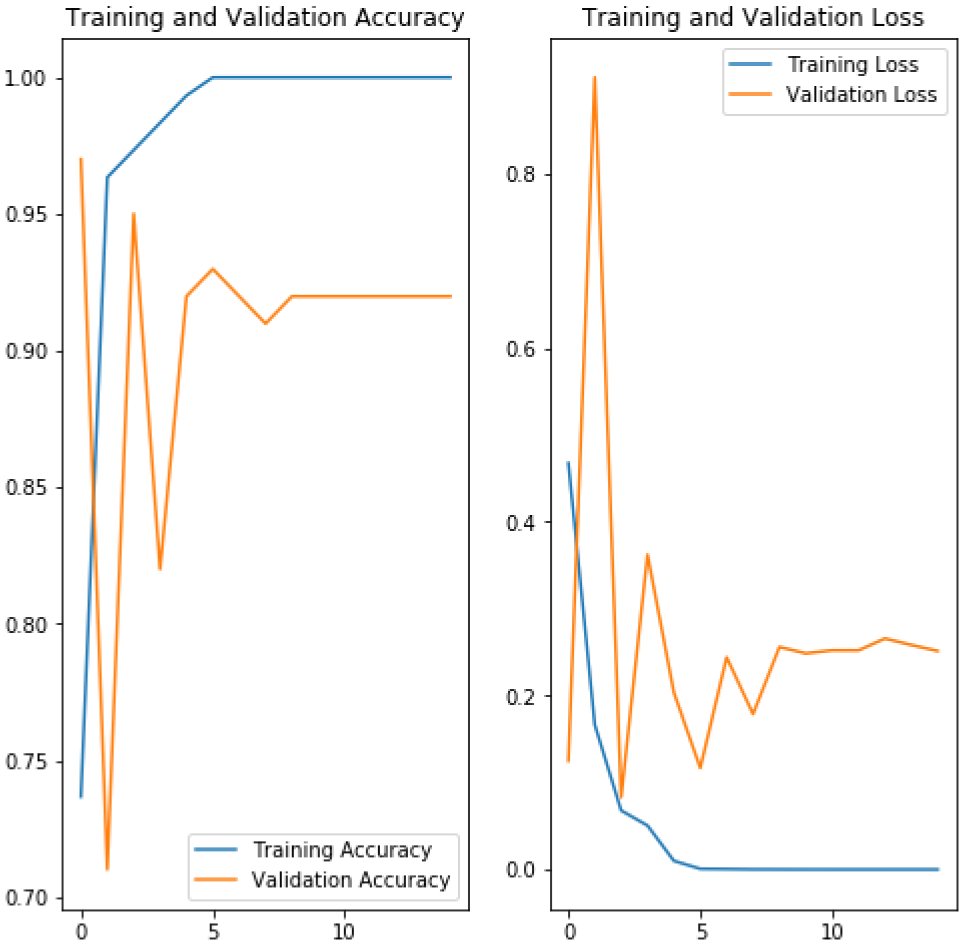
```
acc = history.history['acc']
val_acc = history.history['val_acc']

loss=history.history['loss']
val_loss=history.history['val_loss']

epochs_range = range(epochs)

plt.figure(figsize=(8, 8))
plt.subplot(1, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy')
plt.plot(epochs_range, val_acc, label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(1, 2, 2)
plt.plot(epochs_range, loss, label='Training Loss')
plt.plot(epochs_range, val_loss, label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.show()
```



In [ ]:

```
model.
```

In [120]:

```
sample_testing_images, _ = next(test_data_gen)
```

In [121]:

```
sample_testing_images.shape
```

Out[121]:

```
(10, 150, 150, 3)
```

In [138]:

```
a = sample_testing_images[:1]
```

We can infer from the above graph that the model is trained to perfection and there is no overfitting and great increment in accuracy and reduction in the loss

In [139]:

```
a.shape
```

Out[139]:

```
(1, 150, 150, 3)
```

In [140]:

```
model.predict_proba(a)
```

```
WARNING:tensorflow:Network returning invalid probability values. The
last layer might not normalize predictions into probabilities (like
softmax or sigmoid would).
```

Out[140]:

```
array([[28.28252]], dtype=float32)
```

In [126]:

```
model.save_weights('covidcllassify.h5')
```

Making another Model

In [141]:

```
model2 = Sequential([
    Conv2D(16, 3, padding='same', activation='relu', input_shape=(IMG_HEIGHT, IM
G_WIDTH ,3)),
    MaxPooling2D(),
    Conv2D(32, 3, padding='same', activation='relu'),
    MaxPooling2D(),
    Conv2D(64, 3, padding='same', activation='relu'),
    MaxPooling2D(),
    Flatten(),
    Dense(512, activation='softmax'),
    Dense(1)
])
```

In [142]:

```
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d_6 (Conv2D)            (None, 150, 150, 16)      448       
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 75, 75, 16)        0         
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 75, 75, 32)        4640      
_________________________________________________________________
max_pooling2d_7 (MaxPooling2 (None, 37, 37, 32)        0         
_________________________________________________________________
conv2d_8 (Conv2D)            (None, 37, 37, 64)        18496     
_________________________________________________________________
max_pooling2d_8 (MaxPooling2 (None, 18, 18, 64)        0         
_________________________________________________________________
flatten_2 (Flatten)          (None, 20736)             0         
_________________________________________________________________
dense_4 (Dense)              (None, 512)               10617344  
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 513       
=================================================================
Total params: 10,641,441
Trainable params: 10,641,441
Non-trainable params: 0
_________________________________________________________________
```

In [143]:

```
history2 = model.fit_generator(
    train_data_gen,
    steps_per_epoch=total_train // batch_size,
    epochs=epochs,
    validation_data=test_data_gen,
    validation_steps=total_test // batch_size
)
```

```
Epoch 1/15
29/30 [============================>.] - ETA: 0s - loss: 1.7258e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 23s 768ms/step - loss: 1.76
77e-05 - acc: 1.0000 - val_loss: 0.2583 - val_acc: 0.9200
Epoch 2/15
29/30 [============================>.] - ETA: 0s - loss: 1.6947e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 22s 731ms/step - loss: 1.67
68e-05 - acc: 1.0000 - val_loss: 0.2577 - val_acc: 0.9200
Epoch 3/15
29/30 [============================>.] - ETA: 0s - loss: 1.5127e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 23s 779ms/step - loss: 1.48
52e-05 - acc: 1.0000 - val_loss: 0.2573 - val_acc: 0.9200
Epoch 4/15
29/30 [============================>.] - ETA: 0s - loss: 1.4447e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 21s 704ms/step - loss: 1.39
95e-05 - acc: 1.0000 - val_loss: 0.2552 - val_acc: 0.9200
Epoch 5/15
29/30 [============================>.] - ETA: 0s - loss: 1.3283e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 21s 684ms/step - loss: 1.29
38e-05 - acc: 1.0000 - val_loss: 0.2656 - val_acc: 0.9200
Epoch 6/15
29/30 [============================>.] - ETA: 0s - loss: 1.1781e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 20s 655ms/step - loss: 1.14
05e-05 - acc: 1.0000 - val_loss: 0.2607 - val_acc: 0.9200
Epoch 7/15
29/30 [============================>.] - ETA: 0s - loss: 1.0024e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 20s 681ms/step - loss: 1.07
31e-05 - acc: 1.0000 - val_loss: 0.2644 - val_acc: 0.9200
Epoch 8/15
29/30 [============================>.] - ETA: 0s - loss: 1.0014e-05
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 21s 715ms/step - loss: 1.00
13e-05 - acc: 1.0000 - val_loss: 0.2656 - val_acc: 0.9200
Epoch 9/15
29/30 [============================>.] - ETA: 0s - loss: 9.3506e-06
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 21s 708ms/step - loss: 9.13
55e-06 - acc: 1.0000 - val_loss: 0.2659 - val_acc: 0.9200
Epoch 10/15
29/30 [============================>.] - ETA: 0s - loss: 8.6747e-06
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 20s 656ms/step - loss: 8.51
72e-06 - acc: 1.0000 - val_loss: 0.2691 - val_acc: 0.9200
Epoch 11/15
29/30 [============================>.] - ETA: 0s - loss: 8.1290e-06
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 25s 849ms/step - loss: 8.00
01e-06 - acc: 1.0000 - val_loss: 0.2687 - val_acc: 0.9200
Epoch 12/15
29/30 [============================>.] - ETA: 0s - loss: 7.7032e-06
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 22s 746ms/step - loss: 7.46
40e-06 - acc: 1.0000 - val_loss: 0.2658 - val_acc: 0.9200
Epoch 13/15
```

```
29/30 [============================>.] - ETA: 0s - loss: 6.4882e-06
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 18s 615ms/step - loss: 7.00
33e-06 - acc: 1.0000 - val_loss: 0.2665 - val_acc: 0.9200
Epoch 14/15
29/30 [============================>.] - ETA: 0s - loss: 6.6996e-06
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 20s 652ms/step - loss: 6.51
28e-06 - acc: 1.0000 - val_loss: 0.2747 - val_acc: 0.9200
Epoch 15/15
29/30 [============================>.] - ETA: 0s - loss: 6.0965e-06
- acc: 1.0000Epoch 1/15
30/30 [==============================] - 22s 729ms/step - loss: 6.21
50e-06 - acc: 1.0000 - val_loss: 0.2680 - val_acc: 0.9200
```

In [144]:

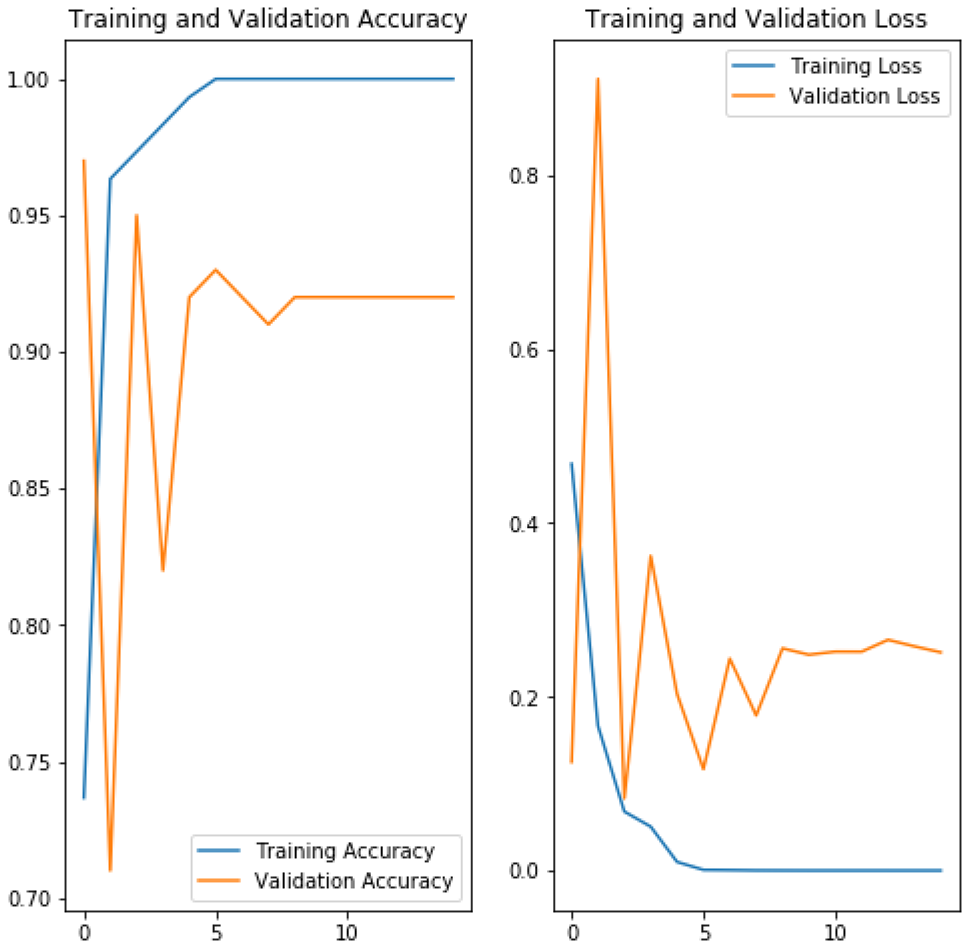
```
acc = history.history['acc']
val_acc = history.history['val_acc']

loss=history.history['loss']
val_loss=history.history['val_loss']

epochs_range = range(epochs)

plt.figure(figsize=(8, 8))
plt.subplot(1, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy')
plt.plot(epochs_range, val_acc, label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(1, 2, 2)
plt.plot(epochs_range, loss, label='Training Loss')
plt.plot(epochs_range, val_loss, label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.show()
```


Training and Validation Accuracy
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0
5
10
Training Accuracy
Validation Accuracy
Training and Validation Loss
0.8
0.6
0.4
0.2
0.0
0
5
10
Training Loss
Validation Loss

In [145]:

```
model.predict_proba(a)
```

```
WARNING:tensorflow:Network returning invalid probability values. The
last layer might not normalize predictions into probabilities (like
softmax or sigmoid would).
```

Out[145]:

```
array([[30.621798]], dtype=float32)
```

No Significant improvement with changing the last layer activiation function

In [ ]:

```
SO we have now built a complete  model which is capable of prediciting weather a
given chest X Ray has coronavirus or now
```