```
from google.colab import drive drive.mount('/content/drive')
```

```
DATA_LIST = os.listdir('/content/drive/My Drive/CC/Covid_Data_GradientCrescent/'
DATASET_PATH  = '/content/drive/My Drive/CC/Covid_Data_GradientCrescent/two/trai
TEST_DIR =  '/content/drive/My Drive/CC/Covid_Data_GradientCrescent/two/test'

IMAGE_SIZE    = (224, 224)
NUM_CLASSES   = len(DATA_LIST)
BATCH_SIZE    = 10  # try reducing batch size or freeze more layers if your GPU
NUM_EPOCHS    = 40
LEARNING_RATE = 0.001 # start off with high rate first 0.001 and experiment with
print("done")
```

```
Mounted at /content/drive
done
```

Generate Training and Validation Batches

```
train_datagen = ImageDataGenerator(rescale=1./255,rotation_range=50,featurewise_
featurewise_std_normalization = True,width_sh
height_shift_range=0.2,shear_range=0.25,zoom_
zca_whitening = True,channel_shift_range = 20
horizontal_flip = True,vertical_flip = True,
validation_split = 0.2,fill_mode='constant')

train_batches = train_datagen.flow_from_directory(DATASET_PATH,target_size=IMAGE
shuffle=True,batch_size=BATCH_
subset = "training",seed=42,
class_mode="binary")

valid_batches = train_datagen.flow_from_directory(DATASET_PATH,target_size=IMAGE
shuffle=True,batch_size=BATCH_
subset = "validation",seed=42,
class_mode="binary")
```

```
/usr/local/lib/python3.7/dist-packages/keras_preprocessing/image/image_data
warnings.warn('This ImageDataGenerator specifies ' Found
104 images belonging to 2 classes.
Found 26 images belonging to 2 classes.
```

```
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import VGG16 from
tensorflow.keras.layers import Dropout from
tensorflow.keras.layers import Flatten from
tensorflow.keras.layers import Dense from
tensorflow.keras.layers import Input from
tensorflow.keras.layers import BatchNormalization
from tensorflow.keras import regularizers #from
tensorflow.keras.models import Model from
tensorflow.keras.optimizers import Adam
```

```
import numpy as np
import argparse
```

```
model = tf.keras.models.Sequential()
model.add (VGG16 (weights= 'imagenet', include_top=False, input_shape =(224,224,
model.add (Flatten()) model.add
(BatchNormalization())
model.add(Dense(units=256,activation="relu"))
model.add(Dropout(0.25))
model.add(Dense(units=1,activation="sigmoid"))
model.layers[0].trainable = False model.summary()
```

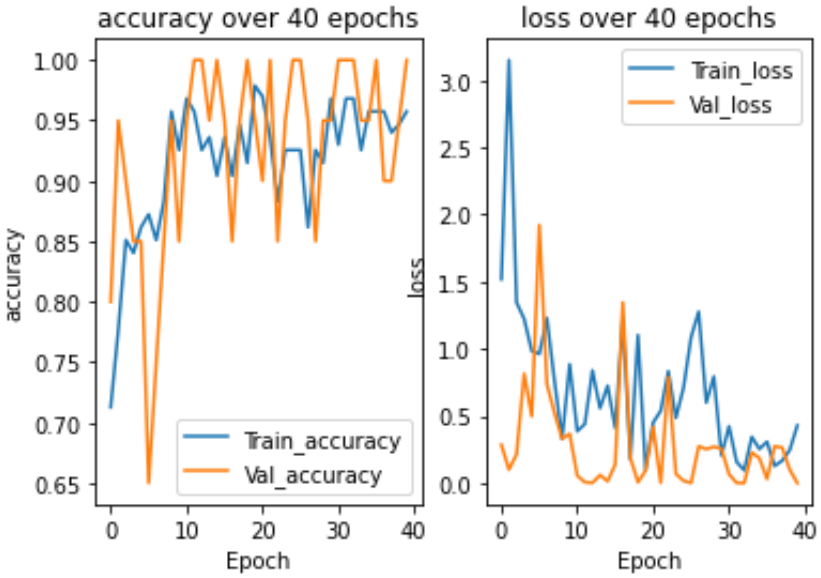
```
Downloading data from https://storage.googleapis.com/tensorflow/keras-appli
58892288/58889256 [==============================] - 0s 0us/step
58900480/58889256 [==============================] - 0s 0us/step Model:
"sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
vgg16 (Functional)          (None, 7, 7, 512)         14714688
flatten (Flatten)           (None, 25088)             0
batch_normalization (BatchN  (None, 25088)            100352
ormalization)
dense (Dense)               (None, 256)               6422784
dropout (Dropout)           (None, 256)               0
dense_1 (Dense)             (None, 1)                 257
=================================================================
Total params: 21,238,081
Trainable params: 6,473,217
Non-trainable params: 14,764,864
_________________________________________________________________
```

```
#FIT MODEL
print(len(train_batches)) print(len(valid_batches))

STEP_SIZE_TRAIN=train_batches.n//train_batches.batch_size
STEP_SIZE_VALID=valid_batches.n//valid_batches.batch_size

model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy']
history = model.fit(x=train_batches,epochs=NUM_EPOCHS,steps_per_epoch=STEP_SIZE_
validation_steps=STEP_SIZE_VALID)
```

```
Epoch 11/40
10/10 [==============================] - 50s 5s/step - loss: 0.3871 - accur
Epoch 12/40
10/10 [==============================] - 50s 5s/step - loss: 0.4407 - accur
Epoch 13/40
10/10 [==============================] - 50s 5s/step - loss: 0.8392 - accur
Epoch 14/40
10/10 [==============================] - 51s 5s/step - loss: 0.5575 - accur
Epoch 15/40
10/10 [==============================] - 51s 5s/step - loss: 0.7256 - accur
Epoch 16/40
10/10 [==============================] - 50s 5s/step - loss: 0.4122 - accur
```

```
Epoch 17/40
10/10 [==============================] - 51s 5s/step - loss: 1.2241 - accur
Epoch 18/40
10/10 [==============================] - 51s 5s/step - loss: 0.1749 - accur
Epoch 19/40
10/10 [==============================] - 51s 5s/step - loss: 1.1028 - accur
Epoch 20/40
10/10 [==============================] - 50s 5s/step - loss: 0.1011 - accur
Epoch 21/40
10/10 [==============================] - 53s 5s/step - loss: 0.4513 - accur
Epoch 22/40
10/10 [==============================] - 50s 5s/step - loss: 0.5381 - accur
Epoch 23/40
10/10 [==============================] - 50s 5s/step - loss: 0.8335 - accur
Epoch 24/40
10/10 [==============================] - 50s 5s/step - loss: 0.4860 - accur
Epoch 25/40
10/10 [==============================] - 50s 5s/step - loss: 0.7099 - accur
Epoch 26/40
10/10 [==============================] - 50s 5s/step - loss: 1.0873 - accur
Epoch 27/40
10/10 [==============================] - 51s 5s/step - loss: 1.2768 - accur
Epoch 28/40
10/10 [==============================] - 51s 5s/step - loss: 0.5998 - accur
Epoch 29/40
10/10 [==============================] - 52s 5s/step - loss: 0.7942 - accur
Epoch 30/40
10/10 [==============================] - 51s 5s/step - loss: 0.2068 - accur
Epoch 31/40
10/10 [==============================] - 54s 5s/step - loss: 0.4232 - accur
Epoch 32/40
10/10 [==============================] - 51s 5s/step - loss: 0.1580 - accur
Epoch 33/40
10/10 [==============================] - 51s 5s/step - loss: 0.0960 - accur
Epoch 34/40
10/10 [==============================] - 50s 5s/step - loss: 0.3441 - accur
Epoch 35/40
10/10 [==============================] - 51s 5s/step - loss: 0.2539 - accur
Epoch 36/40
10/10 [==============================] - 50s 5s/step - loss: 0.3076 - accur
Epoch 37/40
10/10 [==============================] - 50s 5s/step - loss: 0.1277 - accur
Epoch 38/40
10/10 [==============================] - 53s 5s/step - loss: 0.1674 - accur
Epoch 39/40
10/10 [==============================] - 50s 5s/step - loss: 0.2462 - accur
Epoch 40/40
10/10 [==============================] - 50s 5s/step - loss: 0.4294 - accur
```

```
import matplotlib.pyplot as plt

fig, (ax) = plt.subplots(1, 2)

c=0

for i in ['accuracy', 'loss']:
ax[c].plot(history.history[i], label='Train_'+i)
ax[c].plot(history.history['val_'+i], label='Val_'+i)
  ax[c].set_xlabel('Epoch')
ax[c].set_ylabel(i)   if
i=='accuracy':
    ax[c].legend(loc='lower right')
else:     ax[c].legend(loc='upper
right')

  ax[c].set_title(str(i)+' over '+str(NUM_EPOCHS)+' epochs')

c+=1 plt.show()
```



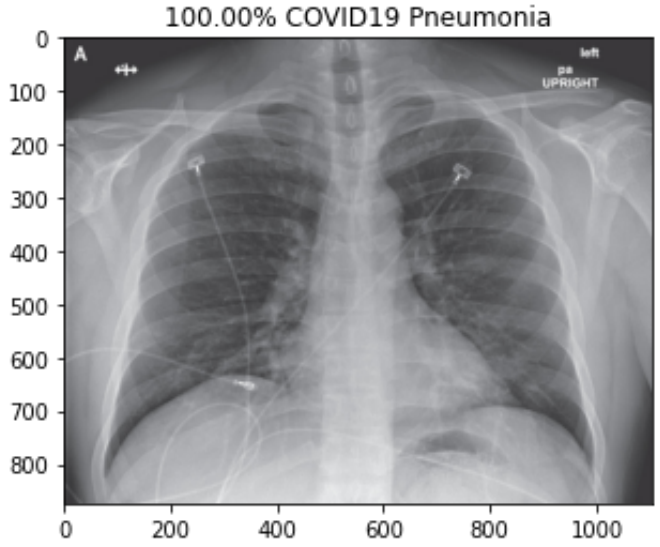
Plot Test Results

```
import matplotlib.image as mpimg

test_datagen = ImageDataGenerator(rescale=1. / 255)
  eval_generator = test_datagen.flow_from_directory(TEST_DIR,target_size=IMAGE_SIZ
                                                    batch_size=1,shuffle=True,seed
eval_generator.reset()
pred = model.predict_generator(eval_generator,18,verbose=1) for
index, probability in enumerate(pred):     image_path = TEST_DIR
+ "/" +eval_generator.filenames[index]
    image = mpimg.imread(image_path)
if image.ndim < 3:
        image = np.reshape(image,(image.shape[0],image.shape[1],1))
        image = np.concatenate([image, image, image], 2)
#         print(image.shape)
```

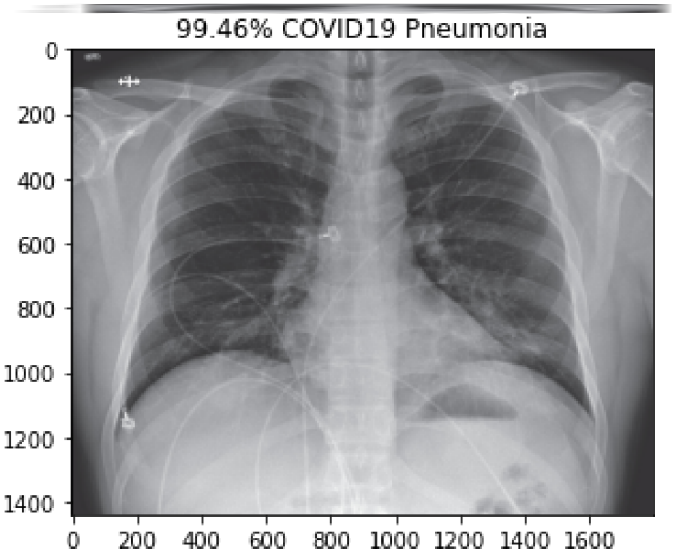
```
    pixels = np.array(image)
plt.imshow(pixels)
```

```
    print(eval_generator.filenames[index])
if probability > 0.5:
        plt.title("%.2f" % (probability[0]*100) + "% Normal")         else:
plt.title("%.2f" % ((1-probability[0])*100) + "% COVID19 Pneumonia")
plt.show()
```

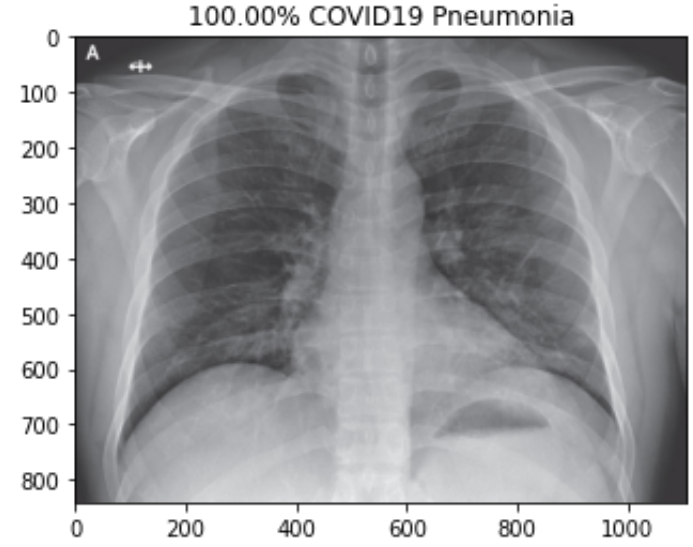
```
Found 18 images belonging to 2 classes.
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:7: UserWarning
import sys
18/18 [==============================] - 9s 495ms/step
covid/nejmoa2001191_f3-PA.jpeg
```



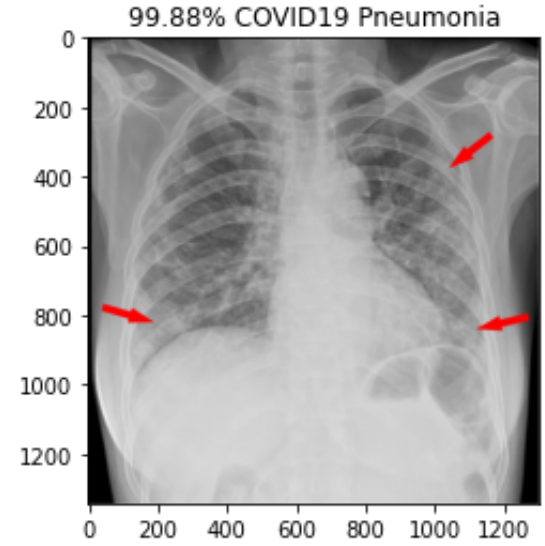

```
covid/nejmoa2001191_f4.jpeg
```



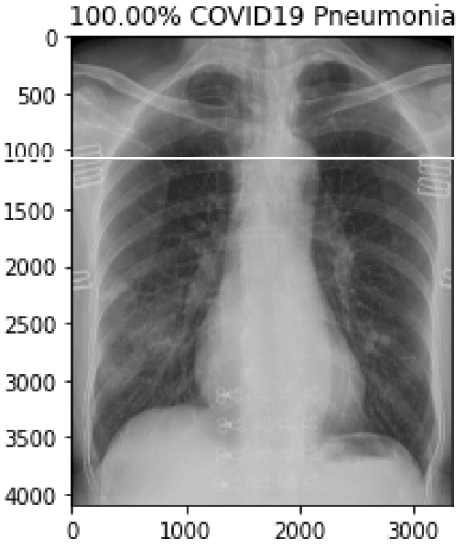

```
covid/nejmoa2001191_f5-PA.jpeg
```



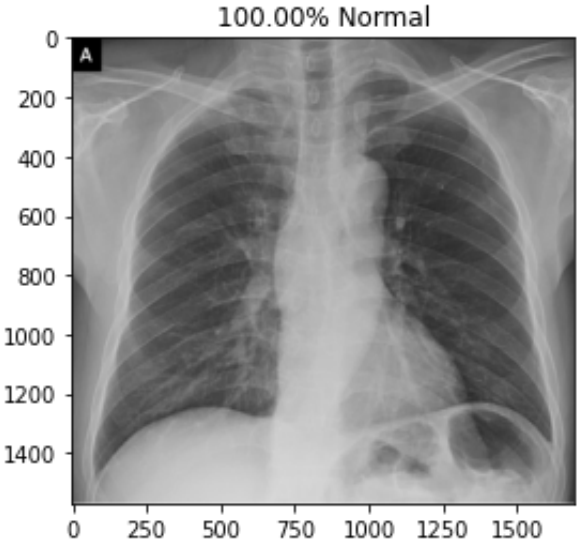
covid/radiol.2020200490.fig3.jpeg



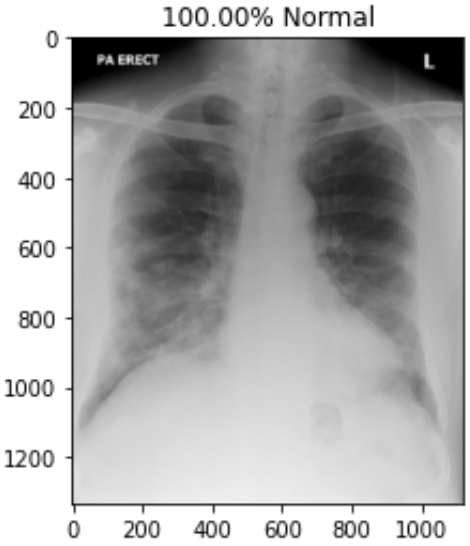
covid/ryct.2020200028.fig1a.jpeg



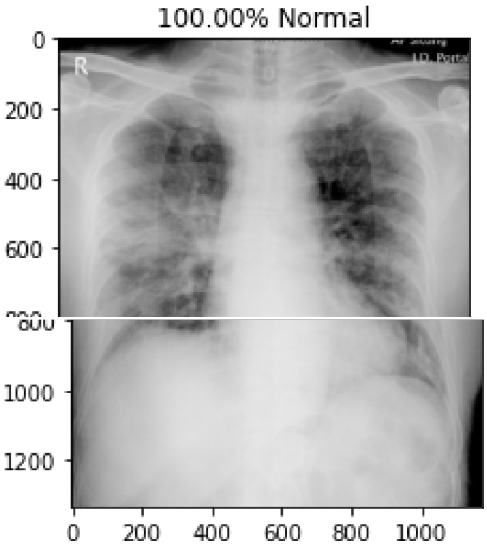
covid/ryct.2020200034.fig2.jpeg



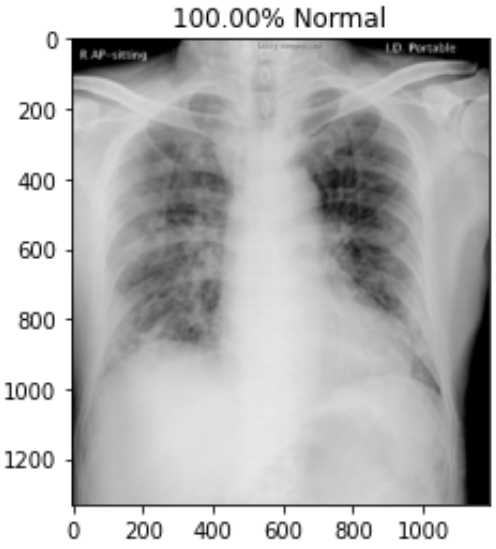
covid/ryct.2020200034.fig5-day0.jpeg



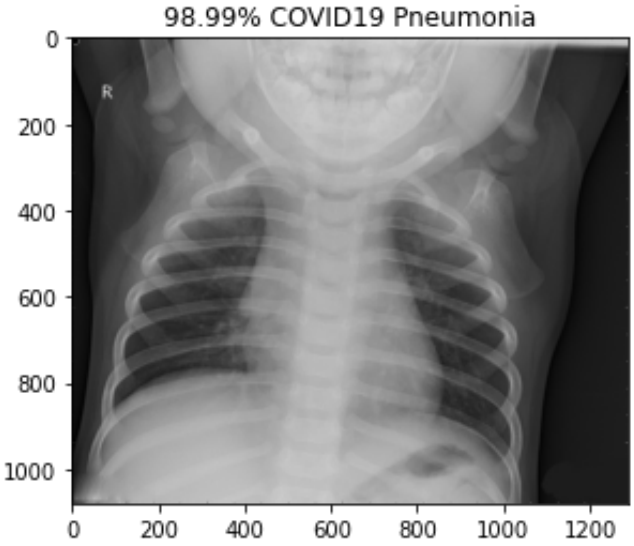
covid/ryct.2020200034.fig5-day4.jpeg



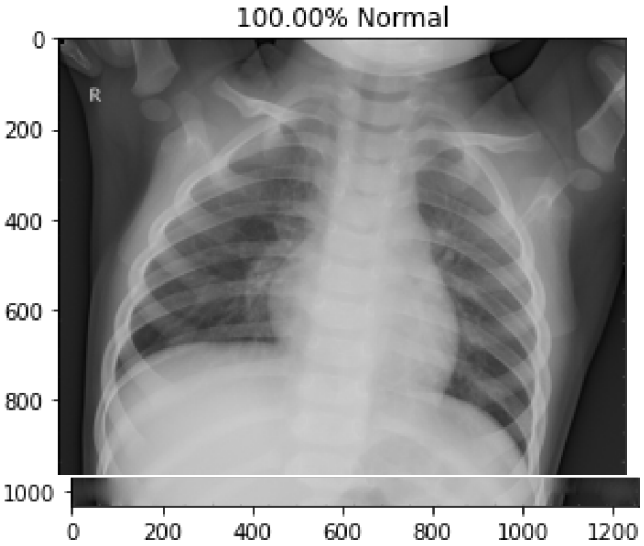
covid/ryct.2020200034.fig5-day7.jpeg



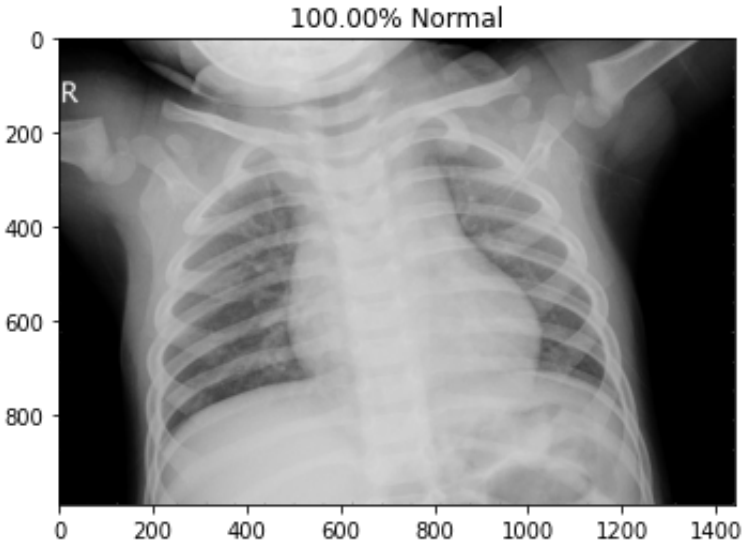
normal/NORMAL2-IM-1385-0001.jpeg



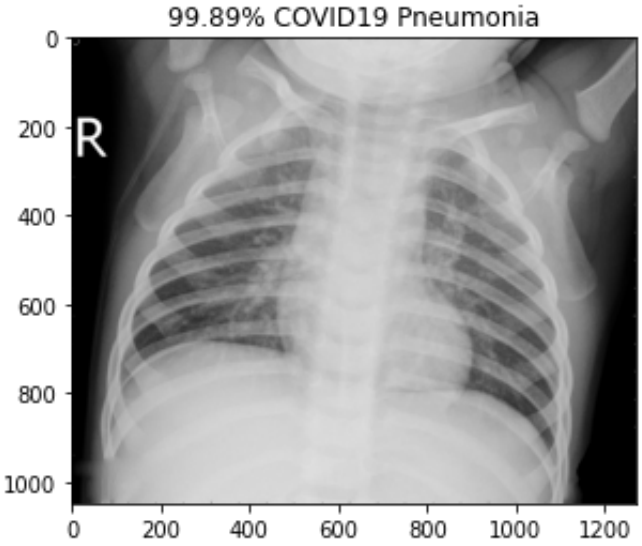
normal/NORMAL2-IM-1396-0001.jpeg



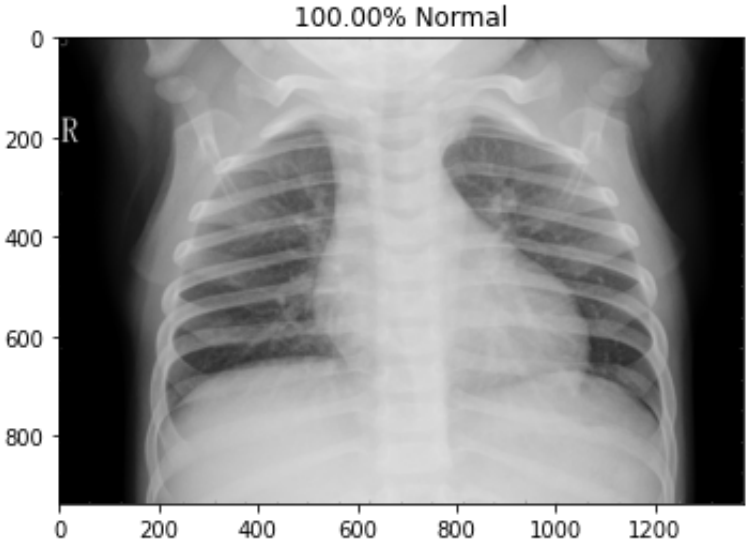
normal/NORMAL2-IM-1400-0001.jpeg




```
normal/NORMAL2-IM-1401-0001.jpeg
```

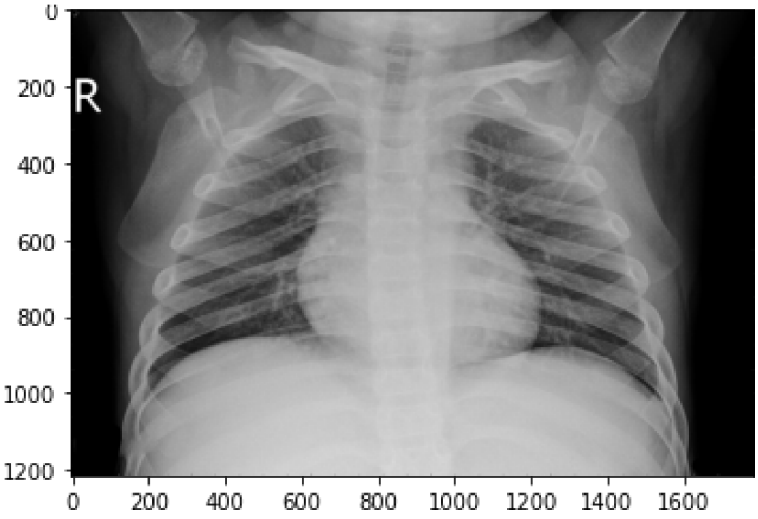



```
normal/NORMAL2-IM-1406-0001.jpeg
```

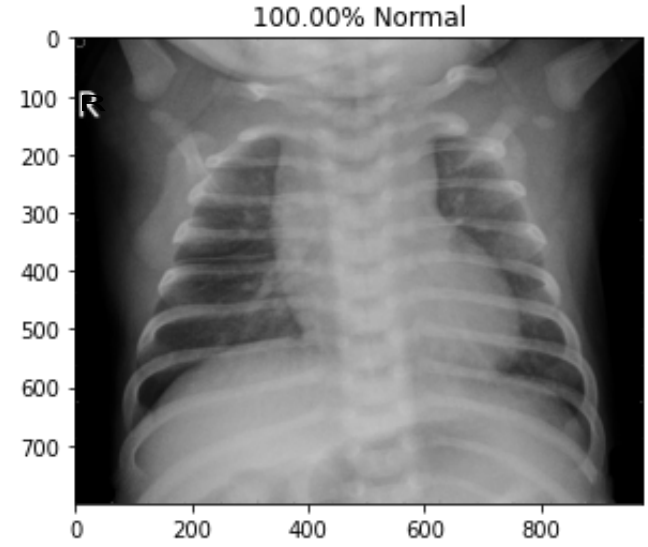



```
normal/NORMAL2-IM-1412-0001.jpeg
```

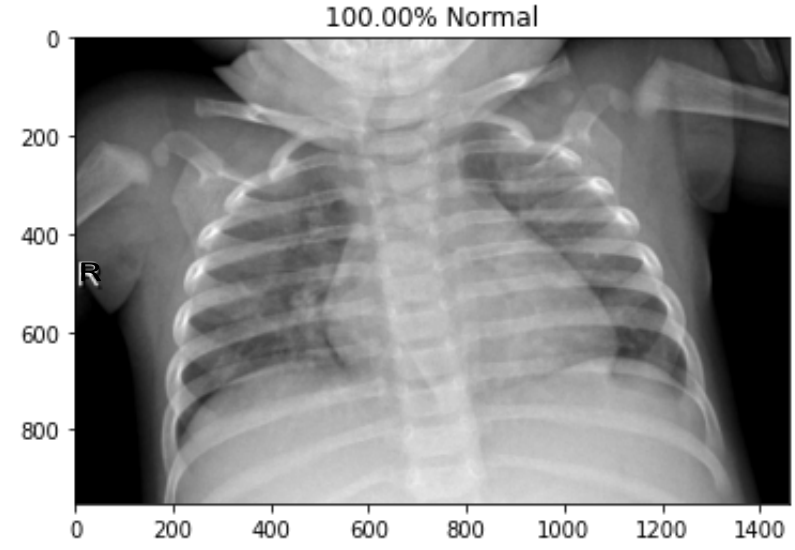
100.00% COVID19 Pneumonia



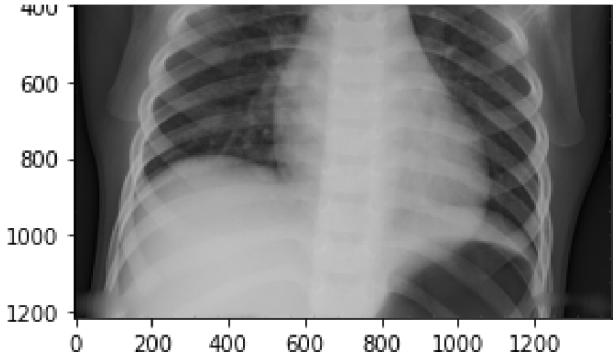
normal/NORMAL2-IM-1419-0001.jpeg



normal/NORMAL2-IM-1422-0001.jpeg

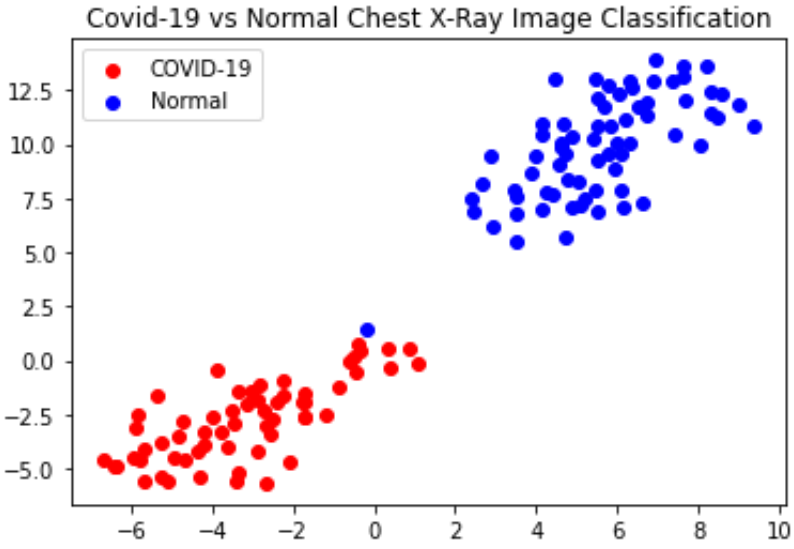


normal/NORMAL2-IM-1423-0001.jpeg




```
from sklearn.manifold import TSNE from tensorflow.keras import models

intermediate_layer_model = models.Model(inputs=model.input, outputs=model.get_l
tsne_data_generator = test_datagen.flow_from_directory(DATASET_PATH,target_size
batch_size=1,shuffle=False,se

activations = intermediate_layer_model.predict(tsne_data_generator, verbose = 1
tsne = TSNE(n_components=2)
tsne_obj = tsne.fit_transform(activations)

x1 = [] x2 = [] y1 = [] y2 = []



for i in range(tsne_obj.shape[0]):
    if(tsne_data_generator.labels[i]==0):
        x1.append(tsne_obj[i,0])
        y1.append(tsne_obj[i,1])
    else:

        x2.append(tsne_obj[i,1])
        y2.append(tsne_obj[i,0])
        y2.append(tsne_obj[i,0])


plt.scatter(x1,y1, c="red", label="COVID-19") plt.scatter(x2,y2, c="blue",
label="Normal")
plt.title('Covid-19 vs Normal Chest X-Ray Image Classification') plt.legend()
plt.show()
```

```
Found 130 images belonging to 2 classes.
130/130 [==============================] - 63s 477ms/step
/usr/local/lib/python3.7/dist-packages/sklearn/manifold/_t_sne.py:783: Futu
FutureWarning,
/usr/local/lib/python3.7/dist-packages/sklearn/manifold/_t_sne.py:793: Futu
FutureWarning,
```



1m 23s completed at 10:16 PM