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

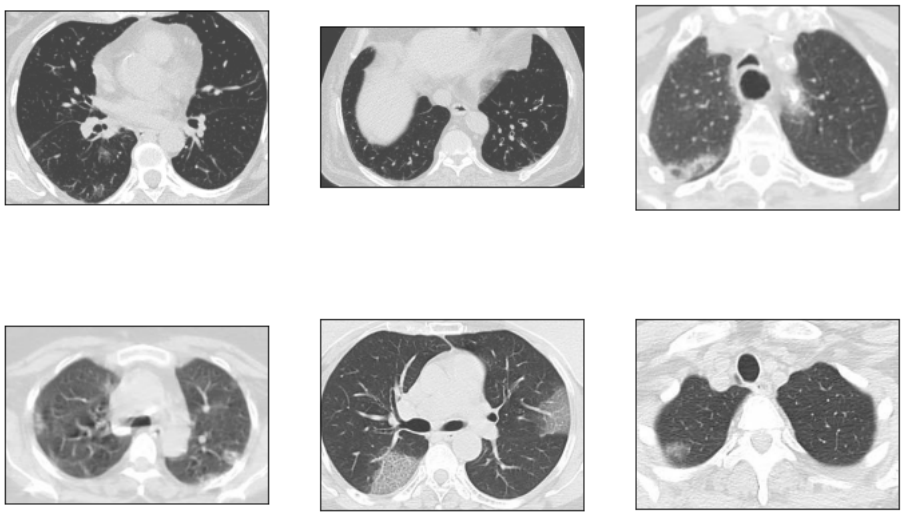
```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

import cv2
import os
from sklearn.metrics import confusion_matrix
from sklearn.model_selection import train_test_split
from keras.utils.np_utils import to_categorical
from keras.models import Model
from keras.layers import Dense, Conv2D, BatchNormalization, GlobalAveragePooling2D
from keras.preprocessing.image import ImageDataGenerator
from keras.layers import Input
from keras.callbacks import ModelCheckpoint, ReduceLROnPlateau
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.applications import DenseNet169
from tensorflow.keras.applications import ResNet101, ResNet152, ResNet50
from tensorflow.keras.utils import plot_model
from tensorflow.keras.callbacks import EarlyStopping


# Supress info, warnings and error messages
os.environ['TF_CPP_MIN_LOG_LEVEL'] = '3'
```

```
disease_types = ['COVID', 'non-COVID']

train_dir = data_dir = '/content/drive/MyDrive/Capstone_project'
train_data = []

for index, sp in enumerate(disease_types):
  for file in os.listdir(os.path.join(train_dir, sp)):
    train_data.append([sp + "/" + file, index, sp])

train = pd.DataFrame(train_data, columns = ['File', 'ID', 'Disease Type'])


Seed = 45
train = train.sample(frac = 1, replace = False, random_state = Seed)

# Reset Index Numbers of dataset
train = train.reset_index(drop = True)

sns.countplot(x = 'ID', data = train).set_title("Frequency Histogram (0: Covid, 1: Non-Covid)")
train
```

	File	ID	Disease Type
0	non-COVID/Non-Covid (392).png	1	non-COVID
1	COVID/Covid (379).png	0	COVID
2	non-COVID/Non-Covid (99).png	1	non-COVID
3	COVID/Covid (171).png	0	COVID
4	COVID/Covid (635).png	0	COVID

```
from collections.abc import ValuesView
def plot_defects(defect_types, rows, cols):
  fig, ax = plt.subplots(rows, cols, figsize=(12, 12))
  defect_files = train['File'][train['Disease Type'] == defect_types].values
  n = 0
  fig.suptitle(defect_types, fontsize = 22, color = "white")
  for i in range(rows):
    for j in range(cols):
      image_path = os.path.join(data_dir, defect_files[n])
      ax[i, j].set_xticks([])
      ax[i, j].set_yticks([])
      ax[i, j].imshow(cv2.imread(image_path))
      n = n+1

plot_defects('COVID', 3, 3)
plot_defects('non-COVID', 3, 3)
```



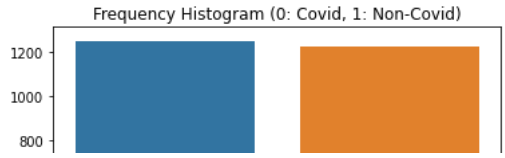
```
IMAGE_SIZE = 224

# OpenCV function to load colored image
def read_image(filepath):
  return cv2.imread(os.path.join(data_dir, filepath))

#OpenCV Function to resize an image
def resize_image(image, image_size):
  return cv2.resize(image.copy(), image_size, interpolation = cv2.INTER_AREA)



 X_train = np.zeros((train.shape[0], IMAGE_SIZE, IMAGE_SIZE, 3))

for i, file in enumerate(train['File'].values):
    image = read_image(file)
    if image is not None:
        X_train[i] = resize_image(image, (IMAGE_SIZE, IMAGE_SIZE))

X_Train = X_train / 255.0   # Pixel normalization
print('Train Shape:', X_Train.shape)

Y_train = to_categorical(train['ID'].values, num_classes = 2)

print(Y_train)
```

```
     Train Shape: (2481, 224, 224, 3)
     [[0. 1.]
      [1. 0.]
      [0. 1.]
      ...
      [0. 1.]
      [0. 1.]
      [0. 1.]]
```

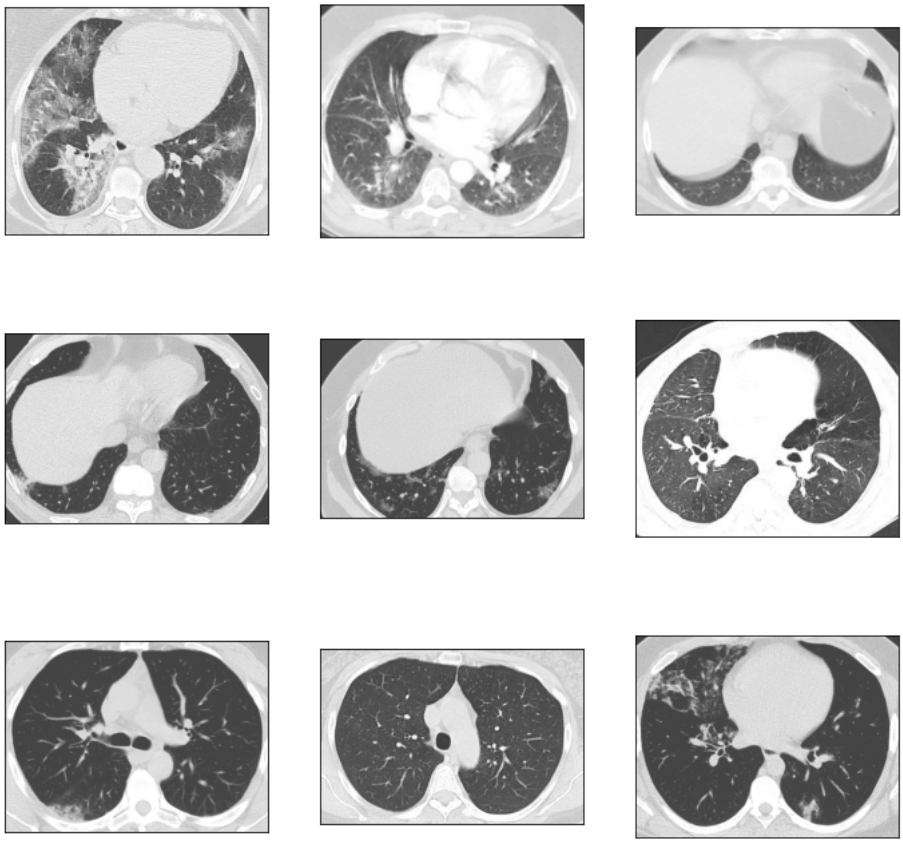
```
Seed = 45
train = train.sample(frac = 1, replace = False, random_state = Seed)

# Reset Index Numbers of dataset
train = train.reset_index(drop = True)

sns.countplot(x = 'ID', data = train).set_title("Frequency Histogram (0: Covid, 1: Non-Covid)")
train
```

	File	ID	Disease Type
0	COVID/Covid (994).png	0	COVID
1	COVID/Covid (438).png	0	COVID
2	non-COVID/Non-Covid (1230).png	1	non-COVID
3	non-COVID/Non-Covid (846).png	1	non-COVID
4	non-COVID/Non-Covid (627).png	1	non-COVID
...	...	...	...
2476	non-COVID/Non-Covid (697).png	1	non-COVID
2477	non-COVID/Non-Covid (352).png	1	non-COVID
2478	non-COVID/Non-Covid (520).png	1	non-COVID
2479	COVID/Covid (1236).png	0	COVID
2480	COVID/Covid (463).png	0	COVID

2481 rows × 3 columns




```
from collections.abc import ValuesView
def plot_defects(defect_types, rows, cols):
  fig, ax = plt.subplots(rows, cols, figsize=(12, 12))
  defect_files = train['File'][train['Disease Type'] == defect_types].values
  n = 0
  fig.suptitle(defect_types, fontsize = 22, color = "white")
  for i in range(rows):
    for j in range(cols):
      image_path = os.path.join(data_dir, defect_files[n])
      ax[i, j].set_xticks([])
      ax[i, j].set_yticks([])
      ax[i, j].imshow(cv2.imread(image_path))
      n = n+1

plot_defects('COVID', 3, 3)
plot_defects('non-COVID', 3, 3)
```



```
IMAGE_SIZE = 224

# OpenCV function to load colored image
def read_image(filepath):
  return cv2.imread(os.path.join(data_dir, filepath))

#OpenCV Function to resize an image
def resize_image(image, image_size):
  return cv2.resize(image.copy(), image_size, interpolation = cv2.INTER_AREA)
```

```
X_train = np.zeros((train.shape[0], IMAGE_SIZE, IMAGE_SIZE, 3))

for i, file in enumerate(train['File'].values):
    image = read_image(file)
    if image is not None:
        X_train[i] = resize_image(image, (IMAGE_SIZE, IMAGE_SIZE))

X_Train = X_train / 255.0   # Pixel normalization
print('Train Shape:', X_Train.shape)

Y_train = to_categorical(train['ID'].values, num_classes = 2)

print(Y_train)
```

```
Train Shape: (2481, 224, 224, 3)
[[1. 0.]
 [1. 0.]
 [0. 1.]
 ...
 [0. 1.]
 [1. 0.]
 [1. 0.]]
```

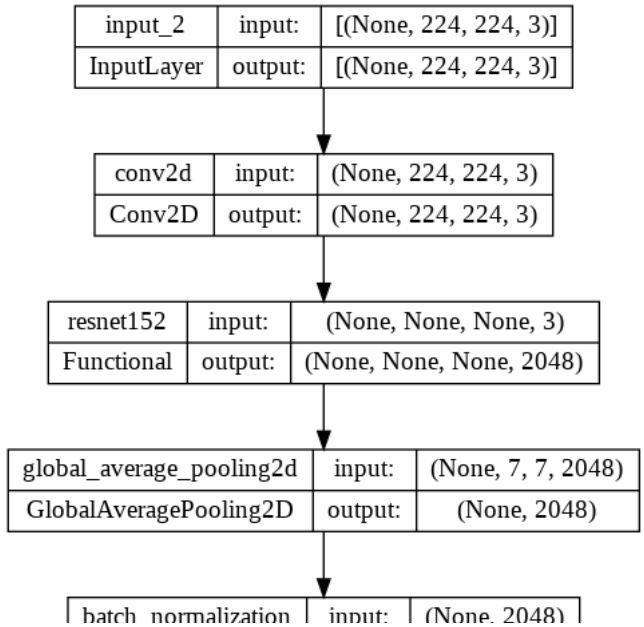
```
# Dataframe split to trin and validation set(80% train and 20% validation)
X_train, X_val, Y_train, Y_val = train_test_split(X_Train, Y_train, test_size = 0.2, random_state = Seed)
```

```
print(f'X_train : {X_train.shape}')
print(f'X_val : {X_val.shape}')
print(f'Y_train : {Y_train.shape}')
print(f'Y_val : {Y_val.shape}')
```

```
X_train : (1984, 224, 224, 3)
X_val : (497, 224, 224, 3)
Y_train : (1984, 2)
Y_val : (497, 2)
```

```
# Architectural function for ResNet152
def build_resnet152(IMAGE_SIZE, channels):

    resNet152 = ResNet152(weights = 'imagenet', include_top = False)

    input = Input(shape = (IMAGE_SIZE, IMAGE_SIZE, channels))
    x = Conv2D(3, (3, 3), padding = 'same')(input)
    x = resNet152(x)
    x = GlobalAveragePooling2D()(x)
    x = BatchNormalization()(x)
    x = Dense(512, activation = 'relu')(x)
    x = BatchNormalization()(x)

    output = Dense(2, activation = 'softmax')(x)

    # model
    model = Model(input, output)

    optimizer = Adam(learning_rate = 0.003, beta_1 = 0.9, beta_2 = 0.999, epsilon = 0.1, decay = 0.0)
    model.compile(loss = 'categorical_crossentropy',  # minimize the negative multinomial log-likelihood also known as the cross-entropy.
                  optimizer = optimizer,
                  metrics = ['accuracy'])
    model.summary()

    return model



channels = 3

model = build_resnet152(IMAGE_SIZE, channels)
annealer = ReduceLROnPlateau(monitor = 'val_accuracy',  # Reduce learning rate when Validation accuracy remains constant
                             factor = 0.70,  # Rate by which the learning rate will decrease
                             patience = 5,   # number of epochs without improvement, after which the learning rate will decrease
                             verbose = 2,    # Display messages
                             min_lr = 1e-4   # lower limit on the learning rate.
                            )
checkpoint = ModelCheckpoint('model.h5', verbose = 2, save_best_only = True)  # Save neural network weights

# Generates batches of image data with data augmentation
datagen = ImageDataGenerator(rotation_range = 360, # Degree range for random rotations
                         width_shift_range = 0.2,   # Range for random horizontal shifts
                         height_shift_range = 0.2,  # Range for random vertical shifts
                         zoom_range = 0.2,          # Range for random zoom
                         horizontal_flip = True,    # Randomly flip inputs horizontally
                         vertical_flip = True)      # Randomly flip inputs vertically

datagen.fit(X_train)

plot_model(model, to_file = 'convnet.png', show_shapes = True, show_layer_names = True)
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_2 (InputLayer)        [(None, 224, 224, 3)]     0

 conv2d (Conv2D)             (None, 224, 224, 3)       84

 resnet152 (Functional)      (None, None, None, 2048)  58370944

 global_average_pooling2d (G  (None, 2048)             0
 lobalAveragePooling2D)

 batch_normalization (BatchN  (None, 2048)             8192
 ormalization)

 dense (Dense)               (None, 512)               1049088

 batch_normalization_1 (Batc  (None, 512)              2048
 hNormalization)

 dense_1 (Dense)             (None, 2)                 1026

=================================================================
Total params: 59,431,382
Trainable params: 59,274,838
Non-trainable params: 156,544
_________________________________________________________________
```




```
Y_pred = model.predict(X_val)

Y_pred = np.argmax(Y_pred, axis = 1)
Y_true = np.argmax(Y_val, axis = 1)

cm = confusion_matrix(Y_true, Y_pred)
plt.figure(figsize = (12, 12))
ax = sns.heatmap(cm, cmap = plt.cm.Greens, annot = True, square = True, xticklabels = disease_types, yticklabels = disease_types)
ax.set_ylabel('Actual', fontsize = 40)
ax.set_xlabel('Predicted', fontsize = 40)


TP = cm[1][1]
print(f"True Positive: {TP}")


FN = cm[1][0]
print(f"False Negative: {FN}")

TN = cm[0][0]
print(f"True Negative: {TN}")

FP = cm[0][1]
print(f"False Positive: {FP}")

# Sensitivity, recall, or true positive rate
print(f"True Positive Rate: {TP / (TP + FN)}")

# Specificity or true negative rate
print(f"True Negative Rate: {TN / (TN + FP)}\n")
```

```
final_loss, final_accuracy = model.evaluate(X_val, Y_val)
print(f"\nFinal Loss: {final_loss}, Final Accuracy: {final_accuracy}")
```

```
16/16 [==============================] - 224s 14s/step
True Positive: 0
False Negative: 268
True Negative: 229
False Positive: 0
True Positive Rate: 0.0
True Negative Rate: 1.0

11/16 [===================>.........] - ETA: 1:12 - loss: 0.7768 - accuracy: 0.4688
```

```
# Accuracy plot
import matplotlib.pyplot as plt
plt.plot(hist.history['accuracy'])
plt.plot(hist.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc = 'upper left')
plt.show()

# Loss plot
plt.plot(hist.history['loss'])
plt.plot(hist.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc = 'upper left')
plt.show()


import keras
import tensorflow.keras.preprocessing.image



keras.utils.load_img



j = 0
k = 0
for i, label in enumerate(Y_pred):

    # Report for positive predicted cases
    if (np.argmax(Y_pred[i]) == 1.0) and (j < 1):
        plt.title("Predicted Report")
        plt.imshow(X_val[i].squeeze(), cmap="gray")
        plt.xlabel(
            "Model predicted the result as POSITIVE with "
            + str(round((np.max(label) * 100), 2))
            + "% chance of Covid Infection",
            fontweight="bold",
        )

        plt.show()
        #plt.savefig("output/figs/positive_predicted_report.png")
        j = j + 1

    # Report for negative predicted cases
    if (np.argmax(Y_pred[i]) == 0.0) and (k < 1):
        plt.title("Predicted Report")
        plt.imshow(X_val[i].squeeze(), cmap="gray")
        plt.xlabel(
            "Model predicted the result as NEGATIVE with "
            + str(round((np.min(label) * 100), 2))
            + "% chance of Covid Infection",
            fontweight="bold",
        )
        #plt.savefig("output/figs/negative_predicted_report.png")
        plt.show()
        k = k + 1
```