Import Libraries

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Conv2D, Flatten, Dropout, MaxPooling2D
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
import matplotlib.pyplot as plt
```

Clone Dataset

```
! git clone https://github.com/education454/datasets.git
```

```
Cloning into 'datasets'...
remote: Enumerating objects: 2301, done.
remote: Total 2301 (delta 0), reused 0 (delta 0), pack-reused 2301
Receiving objects: 100% (2301/2301), 1.31 GiB | 15.37 MiB/s, done.
Checking out files: 100% (2295/2295), done.
```

```
import os
main_dir = '/content/datasets/Data'
train_dir =os.path.join(main_dir,'train')
test_dir = os.path.join(main_dir,'test')
train_covid_dir = os.path.join(train_dir,'COVID19')
train_normal_dir = os.path.join(train_dir,'NORMAL')
test_covid_dir = os.path.join(test_dir,'COVID19')
test_normal_dir = os.path.join(test_dir,'NORMAL')
```



```
print(train_dir,train_covid_dir)
```

```
/content/datasets/Data/train /content/datasets/Data/train/COVID19
```

```
train_covid_names = os.listdir(train_covid_dir)
print(train_covid_names[:10])

train_normal_names = os.listdir(train_normal_dir)
print(train_normal_names[:10])

test_covid_names = os.listdir(test_covid_dir)
print(test_covid_names[:10])

test_normal_names = os.listdir(test_normal_dir)
print(test_normal_names[:10])
```

```
['COVID19(393).jpg', 'COVID19(188).jpg', 'COVID19(76).jpg', 'COVID19(221).jpg', 'COVID-1
['NORMAL(487).jpg', 'NORMAL(313).jpg', 'NORMAL(97).jpg', 'NORMAL(1476).jpg', 'NORMAL(367
['COVID19(160).jpg', 'COVID19(375).jpg', 'COVID-19 (875).jpg', 'COVID19(182).jpg', 'COVI
['NORMAL(356).jpg', 'NORMAL(760).jpg', 'NORMAL(86).jpg', 'NORMAL(10).jpg', 'NORMAL(275)
```

```
print("train dataset covid images :",len(train_covid_names))
print("train dataset normal images :",len(train_normal_names))
print("test dataset covid images :",len(test_covid_names))
print("test dataset normal images :",len(test_normal_names))
print("Total train images :",len(train_covid_names+train_normal_names))
print("Total test images :",len(test_covid_names+test_normal_names))
```

```
train dataset covid images : 545
train dataset normal images : 1266
test dataset covid images : 167
test dataset normal images : 317
Total train images : 1811
Total test images : 484
```

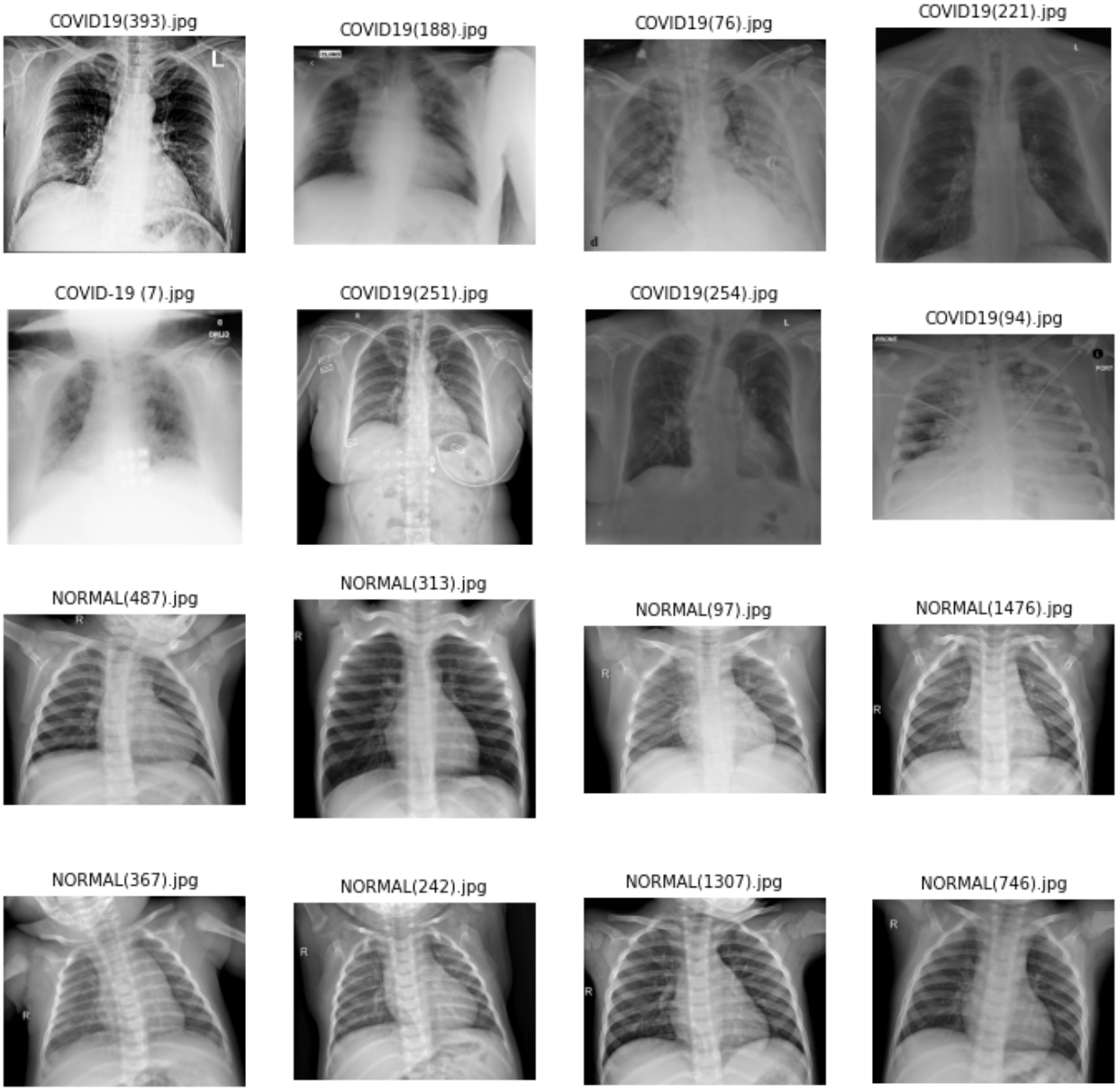
Data Visualization

```
#lets plot a grid of 16 images (8 images of Covid19 and 8 images of Normal)
```

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

#set the number of columns and rows
nrows = 4
ncols = 4

#set the figure size
fig = plt.gcf()
fig.set_size_inches(12,12)

#get the filenames from the covid & normal dir of the train dataset
next_covid_pic = [os.path.join(train_covid_dir,fname)for fname in train_covid_names[0:8]]
next_normal_pic = [os.path.join(train_normal_dir,fname)for fname in train_normal_names[0:8]]

#print the list
print(next_covid_pic)
print(next_normal_pic)

for i , img_path in enumerate(next_covid_pic+next_normal_pic):
  data = img_path.split('/',6)[6]
  sp =plt.subplot(nrows,ncols,i+1)
  sp.axis('Off')
```

```
    sp.axis('off')
    img = mpimg.imread(img_path)
    sp.set_title(data,fontsize=10)
    plt.imshow(img,cmap='gray')

plt.show()
```

```
['/content/datasets/Data/train/COVID19/COVID19(393).jpg', '/content/datasets/Data/
['/content/datasets/Data/train/NORMAL/NORMAL(487).jpg', '/content/datasets/Data/tr
```



Generating Training , Validation & Testing Batches

```
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

```
# Generator for our training data
train_datagen = ImageDataGenerator(rescale = 1./255,
                                   validation_split = 0.2,
                                   zoom_range = 0.2,
                                   horizontal_flip = True)

# Generator for our validation data
validation_datagen = ImageDataGenerator(rescale = 1./255)

# Generator for our test data
test_datagen = ImageDataGenerator(rescale = 1./255)

train_generator = train_datagen.flow_from_directory(train_dir ,
                                                    target_size = (150,150),
                                                    subset = 'training',
                                                    batch_size = 32,
                                                    class_mode = 'binary')

validation_generator = train_datagen.flow_from_directory(train_dir ,
                                                    target_size = (150,150),
                                                    subset = 'validation',
                                                    batch_size = 32,
                                                    class_mode = 'binary')

test_generator = test_datagen.flow_from_directory(test_dir ,
                                                    target_size = (150,150),
                                                    batch_size = 32,
                                                    class_mode = 'binary')
```

```
Found 1449 images belonging to 2 classes.
Found 362 images belonging to 2 classes.
Found 484 images belonging to 2 classes.
```

```
train_generator.class_indices
```

```
{'COVID19': 0, 'NORMAL': 1}
```

```
train_generator.image_shape
```

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

Build CNN Model

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Conv2D, Flatten, Dropout, MaxPooling2D

model = Sequential()
```

```
# add the convolutional layer
# filters, size of filters,padding,activation_function,input_shape
model.add(Conv2D(32,(5,5),padding='SAME',activation='relu',input_shape=(150,150,3)))
# pooling layer
model.add(MaxPooling2D(pool_size=(2,2)))
# place a dropout layer
model.add(Dropout(0.5))
# add another convolutional layer
model.add(Conv2D(64,(5,5),padding='SAME',activation='relu'))

# pooling layer
model.add(MaxPooling2D(pool_size=(2,2)))

# place a dropout layer
model.add(Dropout(0.5))

# Flatten the image to 1 dimensional array
model.add(Flatten())
# add a dense layer : amount of nodes, activation
model.add(Dense(256,activation='relu'))
# place a dropout layer
# 0.5 drop out rate is recommended, half input nodes will be dropped at each update
model.add(Dropout(0.5))
model.add(Dense(1,activation='sigmoid'))
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d (Conv2D)              (None, 150, 150, 32)      2432      
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 75, 75, 32)        0         
_________________________________________________________________
dropout (Dropout)            (None, 75, 75, 32)        0         
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 75, 75, 64)        51264     
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 37, 37, 64)        0         
_________________________________________________________________
dropout_1 (Dropout)          (None, 37, 37, 64)        0         
_________________________________________________________________
flatten (Flatten)            (None, 87616)             0         
_________________________________________________________________
dense (Dense)                (None, 256)               22429952  
_________________________________________________________________
dropout_2 (Dropout)          (None, 256)               0         
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 257       
=================================================================
Total params: 22,483,905
Trainable params: 22,483,905
Non-trainable params: 0
_________________________________________________________________
```

Compile & Train Model

```
#compile the model
from tensorflow.keras.optimizers import Adam
model.compile(Adam(lr = 0.001),loss='binary_crossentropy',metrics=['accuracy'])
```

```
/usr/local/lib/python3.7/dist-packages/keras/optimizer_v2/optimizer_v2.py:356: UserWarni
  "The `lr` argument is deprecated, use `learning_rate` instead.")
```

```
#train the model
history = model.fit(train_generator,
                            epochs=20,
                            validation_data = validation_generator,
                            validation_steps = 10)
```

```
Epoch 1/20
46/46 [==============================] - 78s 1s/step - loss: 0.8955 - accuracy: 0.7771 -
Epoch 2/20
46/46 [==============================] - 46s 1s/step - loss: 0.2147 - accuracy: 0.9220 -
Epoch 3/20
46/46 [==============================] - 45s 994ms/step - loss: 0.1689 - accuracy: 0.936
Epoch 4/20
46/46 [==============================] - 46s 986ms/step - loss: 0.1344 - accuracy: 0.949
Epoch 5/20
46/46 [==============================] - 45s 990ms/step - loss: 0.1307 - accuracy: 0.955
Epoch 6/20
46/46 [==============================] - 46s 997ms/step - loss: 0.1246 - accuracy: 0.961
Epoch 7/20
46/46 [==============================] - 46s 1s/step - loss: 0.1328 - accuracy: 0.9586 -
Epoch 8/20
46/46 [==============================] - 45s 991ms/step - loss: 0.1133 - accuracy: 0.962
Epoch 9/20
46/46 [==============================] - 45s 984ms/step - loss: 0.1103 - accuracy: 0.964
Epoch 10/20
46/46 [==============================] - 45s 987ms/step - loss: 0.0952 - accuracy: 0.961
Epoch 11/20
46/46 [==============================] - 48s 1s/step - loss: 0.0932 - accuracy: 0.9758 -
Epoch 12/20
46/46 [==============================] - 45s 985ms/step - loss: 0.0873 - accuracy: 0.973
Epoch 13/20
46/46 [==============================] - 48s 1s/step - loss: 0.0874 - accuracy: 0.9696 -
Epoch 14/20
46/46 [==============================] - 45s 981ms/step - loss: 0.0772 - accuracy: 0.977
Epoch 15/20
46/46 [==============================] - 45s 975ms/step - loss: 0.0852 - accuracy: 0.969
Epoch 16/20
46/46 [==============================] - 45s 983ms/step - loss: 0.0647 - accuracy: 0.978
Epoch 17/20
46/46 [==============================] - 45s 976ms/step - loss: 0.0489 - accuracy: 0.982
```

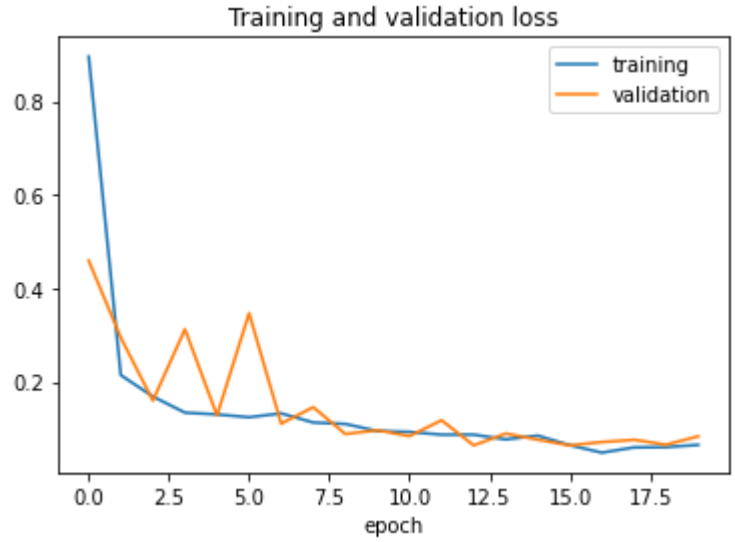
```
Epoch 18/20
46/46 [==============================] - 45s 981ms/step - loss: 0.0601 - accuracy: 0.979
Epoch 19/20
46/46 [==============================] - 45s 981ms/step - loss: 0.0608 - accuracy: 0.980
Epoch 20/20
46/46 [==============================] - 45s 982ms/step - loss: 0.0656 - accuracy: 0.978
```

```
history.history.keys()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

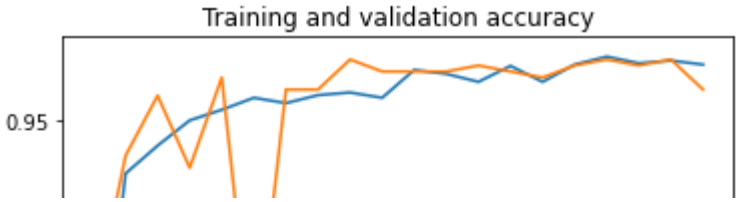
```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.legend(['training','validation'])
plt.title('Training and validation loss')
plt.xlabel('epoch')
```

```
Text(0.5, 0, 'epoch')
```




```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.legend(['training','validation'])
plt.title('Training and validation accuracy')
plt.xlabel('epoch')
```

```
Text(0.5, 0, 'epoch')
```




```
from sklearn.metrics import confusion_matrix, plot_confusion_matrix
import numpy as np

# computing confusion matrix for the test set
y_true = test_generator.classes
probabilities = model.predict(test_generator)
y_pred = probabilities > 0.5

print(confusion_matrix(y_true, y_pred))
# test_loss , test_acc = model.evaluate(test_generator)
# print('test acc :{} test loss:{}'.format(test_acc,test_loss))
```

```
[[ 47 120]
 [ 91 226]]
```

```
#test your model with some images from your local computer to predict whether a patient is af
import numpy as np
from google.colab import files
from keras.preprocessing import image

uploaded = files.upload()
for fn in uploaded.keys():
  path='/content/'+fn
  print(path)
  img = image.load_img(path , target_size=(150,150))
  x = image.img_to_array(img)
  x=np.expand_dims(x,axis=0)
  images = np.vstack([x])
  classes = model.predict(images,batch_size=10)
  print(fn)
  if classes==0:
    print('Covid19')
  else:
    print('Normal')
```

Choose Files No file chosen

```
model.save('model.h5')
```

```
from google.colab import files
files.download('model.h5')
```

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