```
# command to download the dataset (covid_19) the specified URL
!wget http://cb.lk/covid_19
```

```
# unzipping the dataset : covid_19
!unzip covid_19
```

```
# import libraries
import numpy as np
import matplotlib.pyplot as plt
import keras
from keras.layers import *
from keras.models import *
from keras.preprocessing import image
```

```
# CNN based model using keras (with tensorflow backend)
classifier = Sequential() # we have created an object(classifier:modle name) of class sequ
## we are using conv2D layer
## we are not using VGG layer because it works on around 180 million features so our model
classifier.add(Conv2D(32,kernel_size=(3,3),activation = 'relu',input_shape = (224,224,3)))
classifier.add(Conv2D(64,(3,3),activation = 'relu'))
# using 2 convolution layers of kernel size =(3,3) is similar to using one single convolut
# but we don't perfer that becauser to increase non linearity in the model using more relu
classifier.add(MaxPooling2D(pool_size = (2,2)))
classifier.add(Dropout(0.25)) # to find overfitting in the model


classifier.add(Conv2D(64,(3,3),activation = 'relu'))
classifier.add(MaxPooling2D(pool_size = (2,2)))
classifier.add(Dropout(0.25))

classifier.add(Conv2D(128,(3,3),activation = 'relu'))
# as we go deep into model we are increasing the number of convolutional layer because we
# features (i.e complex features)
classifier.add(MaxPooling2D(pool_size = (2,2)))
classifier.add(Dropout(0.25))

classifier.add(Flatten());
classifier.add(Dense(64,activation = 'relu'))
classifier.add(Dropout(0.5))
classifier.add(Dense(1,activation = 'sigmoid'))
```

```
classifier.compile(loss = keras.losses.binary_crossentropy,optimizer = 'adam',metrics =['a
# adam use gradient descent algorithm for optimizing
```

```
classifier.summary()
```

```
Model: "sequential"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d (Conv2D)              (None, 222, 222, 32)      896       
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 220, 220, 64)      18496     
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 110, 110, 64)      0         
_________________________________________________________________
dropout (Dropout)            (None, 110, 110, 64)      0         
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 108, 108, 64)      36928     
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 54, 54, 64)        0         
_________________________________________________________________
dropout_1 (Dropout)          (None, 54, 54, 64)        0         
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 52, 52, 128)       73856     
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 26, 26, 128)       0         
_________________________________________________________________
dropout_2 (Dropout)          (None, 26, 26, 128)       0         
_________________________________________________________________
flatten (Flatten)            (None, 86528)             0         
_________________________________________________________________
dense (Dense)                (None, 64)                5537856   
_________________________________________________________________
dropout_3 (Dropout)          (None, 64)                0         
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 65        
=================================================================
Total params: 5,668,097
Trainable params: 5,668,097
Non-trainable params: 0
_________________________________________________________________
```

```
## training the model
# firstly setting up the data ready for training i.e data preprocessing with the help of I
train_datagen = image.ImageDataGenerator(
    rescale = 1./255,
    shear_range = 0.2,
    zoom_range = 0.2,
    horizontal_flip = True
)
validation_datagen = image.ImageDataGenerator(rescale = 1./255)
# we are dividing by 255 for normalisation


train_data = train_datagen.flow_from_directory('CovidDataset/Train',
                                               target_size = (224,224),
                                               batch_size = 32,
                                               class_mode = 'binary')
# here images get loaded one by one and get reshaped to specified dimensions
```

```
Found 224 images belonging to 2 classes.
```

```
train_data.class_indices
```

```
{'Covid': 0, 'Normal': 1}
```

```
validation_data = validation_datagen.flow_from_directory('CovidDataset/Val',
                                              target_size = (224,224),
                                              batch_size = 32,
                                           class_mode = 'binary')
# here images get loaded one by one and get reshaped to specified dimensions
```

```
Found 60 images belonging to 2 classes.
```

```
validation_data.class_indices
```

```
{'Covid': 0, 'Normal': 1}
```

```
final_model = classifier.fit_generator(train_data,
                         steps_per_epoch= 7,
                        epochs = 10,
                        validation_data = validation_data,
                        validation_steps = 2)
```

```
/usr/local/lib/python3.7/dist-packages/keras/engine/training.py:1915: UserWarning: `
  warnings.warn('`Model.fit_generator` is deprecated and '
Epoch 1/10
7/7 [==============================] - 60s 2s/step - loss: 2.4544 - accuracy: 0.5109
Epoch 2/10
7/7 [==============================] - 10s 1s/step - loss: 0.6694 - accuracy: 0.5805
Epoch 3/10
7/7 [==============================] - 10s 1s/step - loss: 0.6194 - accuracy: 0.6369
Epoch 4/10
7/7 [==============================] - 10s 1s/step - loss: 0.4704 - accuracy: 0.7643
Epoch 5/10
7/7 [==============================] - 10s 1s/step - loss: 0.3884 - accuracy: 0.8215
Epoch 6/10
7/7 [==============================] - 10s 1s/step - loss: 0.2847 - accuracy: 0.8927
Epoch 7/10
7/7 [==============================] - 10s 2s/step - loss: 0.3579 - accuracy: 0.8288
Epoch 8/10
7/7 [==============================] - 10s 1s/step - loss: 0.3073 - accuracy: 0.8699
Epoch 9/10
7/7 [==============================] - 10s 1s/step - loss: 0.1903 - accuracy: 0.9034
Epoch 10/10
7/7 [==============================] - 10s 1s/step - loss: 0.1394 - accuracy: 0.9562
```

```
## with help of "grad CAM" technique we can see and visualize how our model is differentia
## part of network our model is focusing on cilensing map
## can read about class activation
```

```
## saving the model
classifier.save("COVID_19_model.h5")
##Through Keras, models can be saved in three formats:
#YAML format
#JSON format
#HDF5 format
```

```
#HDF5 format
#YAML and JSON files store only model structure, whereas, HDF5 file stores complete neural


# we can load the model when ever required
classifier = load_model("COVID_19_model.h5")



import os  # it is a standard library in python


# setup for confusion matrix
y_validation = []
y_predict = []
for i in os.listdir("./CovidDataset/Val/Normal/"):
  img = image.load_img("./CovidDataset/Val/Normal/"+i,target_size = (224,224))
  img = image.img_to_array(img)
  img = np.expand_dims(img,axis = 0)
  pred = classifier.predict_classes(img)
  y_predict.append(pred[0,0])
  y_validation.append(1)
for i in os.listdir("./CovidDataset/Val/Covid/"):
  img = image.load_img("./CovidDataset/Val/Covid/"+i,target_size = (224,224))
  img = image.img_to_array(img)
  img = np.expand_dims(img,axis = 0)
  pred = classifier.predict_classes(img)
  y_predict.append(pred[0,0])
  y_validation.append(0)
y_validation = np.array(y_validation)
y_predict = np.array(y_predict)
```

```
/usr/local/lib/python3.7/dist-packages/keras/engine/sequential.py:450: UserWarning:
  warnings.warn('`model.predict_classes()` is deprecated and '
```

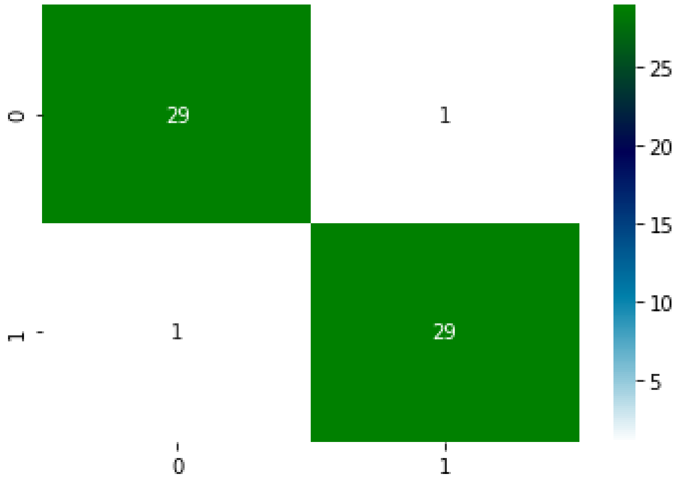
```
# now importing sklearn for confusion matrix
from sklearn.metrics import confusion_matrix
# sklearn provides a selection of efficient tools for machine learning and statistical moc
#including classification, regression, clustering and dimensionality reduction via a consi

con_matrix = confusion_matrix(y_validation,y_predict)


import seaborn as sns
#Seaborn is an open-source Python library built on top of matplotlib.
#It is used for data visualization and exploratory data analysis.
#Seaborn works easily with dataframes and the Pandas library.

sns.heatmap(con_matrix,cmap = "ocean_r",annot = True)
# Heatmap is defined as a graphical representation of data using colors to visualize the
# cmap is for color map (ex : ocean, ocean_r, pink, pink_r, plasma )
# annot : When we pass bool ‘True‘ value to annot then the value will show on each cell of
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fa815153890>
```



29
1
1
29
0
1
0
1
25
20
15
10
5