

```
import tensorflow as tf
import pandas as pd
import matplotlib.pyplot as plt
from tensorflow.keras import Model
from tensorflow.keras.layers import Conv2D, Dense, MaxPooling2D, Dropout, Flatten, GlobalAveragePooling2D
from tensorflow.keras.models import Sequential
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.callbacks import ReduceLROnPlateau
from tensorflow.keras.layers import Input, Lambda, Dense, Flatten
from tensorflow.keras.models import Model
from tensorflow.keras.applications.inception_v3 import InceptionV3
from tensorflow.keras.applications.inception_v3 import preprocess_input
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.models import Sequential
import numpy as np
from glob import glob
```

```
!mkdir -p ~/.kaggle
!cp kaggle.json ~/.kaggle/
!chmod 600 ~/.kaggle/kaggle.json
```

→ cp: cannot stat 'kaggle.json': No such file or directory  
chmod: cannot access '/root/.kaggle/kaggle.json': No such file or directory

```
!kaggle datasets download -d mohamedhanyyy/chest-ctscan-images
```

→ Dataset URL: <https://www.kaggle.com/datasets/mohamedhanyyy/chest-ctscan-images>  
License(s): ODbL-1.0  
Downloading chest-ctscan-images.zip to /content  
99% 118M/119M [00:01<00:00, 124MB/s]  
100% 119M/119M [00:01<00:00, 100MB/s]

```
from zipfile import ZipFile
file_name = "chest-ctscan-images.zip"

with ZipFile(file_name, 'r') as zip:
    zip.extractall()
    print('Done')
```

→ Done

```
InceptionV3_model = tf.keras.applications.InceptionV3(weights='imagenet', include_top=False,
```

→ Downloading data from [https://storage.googleapis.com/tensorflow/keras-applications/inception\\_v3/](https://storage.googleapis.com/tensorflow/keras-applications/inception_v3/) 1s 0us/step

```
from tensorflow.keras import Model
from tensorflow.keras.layers import Conv2D, Dense, MaxPooling2D, Dropout, Flatten, GlobalAveragePooling2D
from tensorflow.keras.models import Sequential

# The last 15 layers fine tune
for layer in InceptionV3_model.layers[:-15]:
    layer.trainable = False

x = InceptionV3_model.output
x = GlobalAveragePooling2D()(x)
x = Flatten()(x)
x = Dense(units=512, activation='relu')(x)
x = Dropout(0.3)(x)
x = Dense(units=512, activation='relu')(x)
x = Dropout(0.3)(x)
output = Dense(units=4, activation='softmax')(x)
model = Model(InceptionV3_model.input, output)
model.summary()
```



(BatchNormalization)			
activation_3 (Activation)	(None, 54, 54, 80)	0	batch_normalizat
conv2d_4 (Conv2D)	(None, 52, 52, 192)	138,240	activation_3[0]
batch_normalization_4 (BatchNormalization)	(None, 52, 52, 192)	576	conv2d_4[0][0]
activation_4 (Activation)	(None, 52, 52, 192)	0	batch_normalizat
max_pooling2d_1 (MaxPooling2D)	(None, 25, 25, 192)	0	activation_4[0]
conv2d_8 (Conv2D)	(None, 25, 25, 64)	12,288	max_pooling2d_1
batch_normalization_8 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_8[0][0]
activation_8 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
conv2d_6 (Conv2D)	(None, 25, 25, 48)	9,216	max_pooling2d_1
conv2d_9 (Conv2D)	(None, 25, 25, 96)	55,296	activation_8[0]

batch_normalization_6 (BatchNormalization)	(None, 25, 25, 48)	144	conv2d_6[0][0]
batch_normalization_9 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_9[0][0]
activation_6 (Activation)	(None, 25, 25, 48)	0	batch_normalizat
activation_9 (Activation)	(None, 25, 25, 96)	0	batch_normalizat
average_pooling2d (AveragePooling2D)	(None, 25, 25, 192)	0	max_pooling2d_1
conv2d_5 (Conv2D)	(None, 25, 25, 64)	12,288	max_pooling2d_1
conv2d_7 (Conv2D)	(None, 25, 25, 64)	76,800	activation_6[0]
conv2d_10 (Conv2D)	(None, 25, 25, 96)	82,944	activation_9[0]
conv2d_11 (Conv2D)	(None, 25, 25, 32)	6,144	average_pooling
batch_normalization_5 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_5[0][0]
batch_normalization_7 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_7[0][0]
batch_normalization_10 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_10[0][0]
batch_normalization_11 (BatchNormalization)	(None, 25, 25, 32)	96	conv2d_11[0][0]
activation_5 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
activation_7 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
activation_10 (Activation)	(None, 25, 25, 96)	0	batch_normalizat
activation_11 (Activation)	(None, 25, 25, 32)	0	batch_normalizat
mixed0 (Concatenate)	(None, 25, 25, 256)	0	activation_5[0]  activation_7[0]  activation_10[0]  activation_11[0]
conv2d_15 (Conv2D)	(None, 25, 25, 64)	16,384	mixed0[0][0]
batch_normalization_15 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_15[0][0]
activation_15 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
conv2d_13 (Conv2D)	(None, 25, 25, 48)	12,288	mixed0[0][0]

conv2d_16 (Conv2D)	(None, 25, 25, 96)	55,296	activation_15[0]
batch_normalization_13 (BatchNormalization)	(None, 25, 25, 48)	144	conv2d_13[0][0]
batch_normalization_16 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_16[0][0]
activation_13 (Activation)	(None, 25, 25, 48)	0	batch_normalizat
activation_16 (Activation)	(None, 25, 25, 96)	0	batch_normalizat
average_pooling2d_1 (AveragePooling2D)	(None, 25, 25, 256)	0	mixed0[0][0]
conv2d_12 (Conv2D)	(None, 25, 25, 64)	16,384	mixed0[0][0]
conv2d_14 (Conv2D)	(None, 25, 25, 64)	76,800	activation_13[0]
conv2d_17 (Conv2D)	(None, 25, 25, 96)	82,944	activation_16[0]
conv2d_18 (Conv2D)	(None, 25, 25, 64)	16,384	average_pooling2
batch_normalization_12 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_12[0][0]
batch_normalization_14 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_14[0][0]
batch_normalization_17 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_17[0][0]
batch_normalization_18 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_18[0][0]
activation_12 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
activation_14 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
activation_17 (Activation)	(None, 25, 25, 96)	0	batch_normalizat
activation_18 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
mixed1 (Concatenate)	(None, 25, 25, 288)	0	activation_12[0] activation_14[0] activation_17[0] activation_18[0]
conv2d_22 (Conv2D)	(None, 25, 25, 64)	18,432	mixed1[0][0]
batch normalization 22	(None, 25, 25, 64)	192	conv2d_22[0][0]

	(BatchNormalization)		
activation_22 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
conv2d_20 (Conv2D)	(None, 25, 25, 48)	13,824	mixed1[0][0]
conv2d_23 (Conv2D)	(None, 25, 25, 96)	55,296	activation_22[0]
batch_normalization_20 (BatchNormalization)	(None, 25, 25, 48)	144	conv2d_20[0][0]
batch_normalization_23 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_23[0][0]
activation_20 (Activation)	(None, 25, 25, 48)	0	batch_normalizat
activation_23 (Activation)	(None, 25, 25, 96)	0	batch_normalizat
average_pooling2d_2 (AveragePooling2D)	(None, 25, 25, 288)	0	mixed1[0][0]
conv2d_19 (Conv2D)	(None, 25, 25, 64)	18,432	mixed1[0][0]
conv2d_21 (Conv2D)	(None, 25, 25, 64)	76,800	activation_20[0]
conv2d_24 (Conv2D)	(None, 25, 25, 96)	82,944	activation_23[0]
conv2d_25 (Conv2D)	(None, 25, 25, 64)	18,432	average_pooling2
batch_normalization_19 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_19[0][0]
batch_normalization_21 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_21[0][0]
batch_normalization_24 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_24[0][0]
batch_normalization_25 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_25[0][0]
activation_19 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
activation_21 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
activation_24 (Activation)	(None, 25, 25, 96)	0	batch_normalizat
activation_25 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
mixed2 (Concatenate)	(None, 25, 25, 288)	0	activation_19[0]

			activation_21[0] activation_24[0] activation_25[0]
conv2d_27 (Conv2D)	(None, 25, 25, 64)	18,432	mixed2[0][0]
batch_normalization_27 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_27[0][0]
activation_27 (Activation)	(None, 25, 25, 64)	0	batch_normalizat
conv2d_28 (Conv2D)	(None, 25, 25, 96)	55,296	activation_27[0]
batch_normalization_28 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_28[0][0]
activation_28 (Activation)	(None, 25, 25, 96)	0	batch_normalizat
conv2d_26 (Conv2D)	(None, 12, 12, 384)	995,328	mixed2[0][0]
conv2d_29 (Conv2D)	(None, 12, 12, 96)	82,944	activation_28[0]
batch_normalization_26 (BatchNormalization)	(None, 12, 12, 384)	1,152	conv2d_26[0][0]
batch_normalization_29 (BatchNormalization)	(None, 12, 12, 96)	288	conv2d_29[0][0]
activation_26 (Activation)	(None, 12, 12, 384)	0	batch_normalizat
activation_29 (Activation)	(None, 12, 12, 96)	0	batch_normalizat
max_pooling2d_2 (MaxPooling2D)	(None, 12, 12, 288)	0	mixed2[0][0]
mixed3 (Concatenate)	(None, 12, 12, 768)	0	activation_26[0] activation_29[0] max_pooling2d_2[0]
conv2d_34 (Conv2D)	(None, 12, 12, 128)	98,304	mixed3[0][0]
batch_normalization_34 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_34[0][0]
activation_34 (Activation)	(None, 12, 12, 128)	0	batch_normalizat
conv2d_35 (Conv2D)	(None, 12, 12, 128)	114,688	activation_34[0]
batch_normalization_35 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_35[0][0]
activation_35 (Activation)	(None, 12, 12, 128)	0	batch_normalizat

conv2d_31 (Conv2D)	(None, 12, 12, 128)	98,304	mixed3[0][0]
conv2d_36 (Conv2D)	(None, 12, 12, 128)	114,688	activation_35[0]
batch_normalization_31 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_31[0][0]
batch_normalization_36 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_36[0][0]
activation_31 (Activation)	(None, 12, 12, 128)	0	batch_normalizat
activation_36 (Activation)	(None, 12, 12, 128)	0	batch_normalizat
conv2d_32 (Conv2D)	(None, 12, 12, 128)	114,688	activation_31[0]
conv2d_37 (Conv2D)	(None, 12, 12, 128)	114,688	activation_36[0]
batch_normalization_32 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_32[0][0]
batch_normalization_37 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_37[0][0]
activation_32 (Activation)	(None, 12, 12, 128)	0	batch_normalizat
activation_37 (Activation)	(None, 12, 12, 128)	0	batch_normalizat
average_pooling2d_3 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed3[0][0]
conv2d_30 (Conv2D)	(None, 12, 12, 192)	147,456	mixed3[0][0]
conv2d_33 (Conv2D)	(None, 12, 12, 192)	172,032	activation_32[0]
conv2d_38 (Conv2D)	(None, 12, 12, 192)	172,032	activation_37[0]
conv2d_39 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2
batch_normalization_30 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_30[0][0]
batch_normalization_33 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_33[0][0]
batch_normalization_38 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_38[0][0]
batch_normalization_39 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_39[0][0]
activation_30 (Activation)	(None, 12, 12, 192)	0	batch_normalizat

activation_33 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_38 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_39 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
mixed4 (Concatenate)	(None, 12, 12, 768)	0	activation_30[0] activation_33[0] activation_38[0] activation_39[0]
conv2d_44 (Conv2D)	(None, 12, 12, 160)	122,880	mixed4[0][0]
batch_normalization_44 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_44[0][0]
activation_44 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
conv2d_45 (Conv2D)	(None, 12, 12, 160)	179,200	activation_44[0]
batch_normalization_45 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_45[0][0]
activation_45 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
conv2d_41 (Conv2D)	(None, 12, 12, 160)	122,880	mixed4[0][0]
conv2d_46 (Conv2D)	(None, 12, 12, 160)	179,200	activation_45[0]
batch_normalization_41 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_41[0][0]
batch_normalization_46 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_46[0][0]
activation_41 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
activation_46 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
conv2d_42 (Conv2D)	(None, 12, 12, 160)	179,200	activation_41[0]
conv2d_47 (Conv2D)	(None, 12, 12, 160)	179,200	activation_46[0]
batch_normalization_42 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_42[0][0]
batch_normalization_47 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_47[0][0]
activation_42 (Activation)	(None, 12, 12, 160)	0	batch_normalizat

activation_42 (Activation)	(None, 12, 12, 100)	0	batch_normalizat
activation_47 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
average_pooling2d_4 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed4[0][0]
conv2d_40 (Conv2D)	(None, 12, 12, 192)	147,456	mixed4[0][0]
conv2d_43 (Conv2D)	(None, 12, 12, 192)	215,040	activation_42[0]
conv2d_48 (Conv2D)	(None, 12, 12, 192)	215,040	activation_47[0]
conv2d_49 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2
batch_normalization_40 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_40[0][0]
batch_normalization_43 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_43[0][0]
batch_normalization_48 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_48[0][0]
batch_normalization_49 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_49[0][0]
activation_40 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_43 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_48 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_49 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
mixed5 (Concatenate)	(None, 12, 12, 768)	0	activation_40[0] activation_43[0] activation_48[0] activation_49[0]
conv2d_54 (Conv2D)	(None, 12, 12, 160)	122,880	mixed5[0][0]
batch_normalization_54 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_54[0][0]
activation_54 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
conv2d_55 (Conv2D)	(None, 12, 12, 160)	179,200	activation_54[0]
batch_normalization_55 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_55[0][0]

activation_55 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
conv2d_51 (Conv2D)	(None, 12, 12, 160)	122,880	mixed5[0][0]
conv2d_56 (Conv2D)	(None, 12, 12, 160)	179,200	activation_55[0]
batch_normalization_51 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_51[0][0]
batch_normalization_56 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_56[0][0]
activation_51 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
activation_56 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
conv2d_52 (Conv2D)	(None, 12, 12, 160)	179,200	activation_51[0]
conv2d_57 (Conv2D)	(None, 12, 12, 160)	179,200	activation_56[0]
batch_normalization_52 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_52[0][0]
batch_normalization_57 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_57[0][0]
activation_52 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
activation_57 (Activation)	(None, 12, 12, 160)	0	batch_normalizat
average_pooling2d_5 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed5[0][0]
conv2d_50 (Conv2D)	(None, 12, 12, 192)	147,456	mixed5[0][0]
conv2d_53 (Conv2D)	(None, 12, 12, 192)	215,040	activation_52[0]
conv2d_58 (Conv2D)	(None, 12, 12, 192)	215,040	activation_57[0]
conv2d_59 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling
batch_normalization_50 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_50[0][0]
batch_normalization_53 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_53[0][0]
batch_normalization_58 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_58[0][0]
batch_normalization_59 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_59[0][0]

activation_50 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_53 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_58 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_59 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
mixed6 (Concatenate)	(None, 12, 12, 768)	0	activation_50[0] activation_53[0] activation_58[0] activation_59[0]
conv2d_64 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0][0]
batch_normalization_64 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_64[0][0]
activation_64 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
conv2d_65 (Conv2D)	(None, 12, 12, 192)	258,048	activation_64[0]
batch_normalization_65 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_65[0][0]
activation_65 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
conv2d_61 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0][0]
conv2d_66 (Conv2D)	(None, 12, 12, 192)	258,048	activation_65[0]
batch_normalization_61 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_61[0][0]
batch_normalization_66 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_66[0][0]
activation_61 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_66 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
conv2d_62 (Conv2D)	(None, 12, 12, 192)	258,048	activation_61[0]
conv2d_67 (Conv2D)	(None, 12, 12, 192)	258,048	activation_66[0]
batch_normalization_62 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_62[0][0]
batch_normalization_67	(None, 12, 12, 192)	576	conv2d_67[0][0]

batch_normalization_62 (BatchNormalization)	(None, 12, 12, 192)	0	conv2d_60[0][0]
activation_62 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_67 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
average_pooling2d_6 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed6[0][0]
conv2d_60 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0][0]
conv2d_63 (Conv2D)	(None, 12, 12, 192)	258,048	activation_62[0]
conv2d_68 (Conv2D)	(None, 12, 12, 192)	258,048	activation_67[0]
conv2d_69 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2
batch_normalization_60 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_60[0][0]
batch_normalization_63 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_63[0][0]
batch_normalization_68 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_68[0][0]
batch_normalization_69 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_69[0][0]
activation_60 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_63 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_68 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_69 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
mixed7 (Concatenate)	(None, 12, 12, 768)	0	activation_60[0] activation_63[0] activation_68[0] activation_69[0]
conv2d_72 (Conv2D)	(None, 12, 12, 192)	147,456	mixed7[0][0]
batch_normalization_72 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_72[0][0]
activation_72 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
conv2d_73 (Conv2D)	(None, 12, 12, 192)	258,048	activation_72[0]

batch_normalization_73 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_73[0][0]
activation_73 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
conv2d_70 (Conv2D)	(None, 12, 12, 192)	147,456	mixed7[0][0]
conv2d_74 (Conv2D)	(None, 12, 12, 192)	258,048	activation_73[0]
batch_normalization_70 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_70[0][0]
batch_normalization_74 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_74[0][0]
activation_70 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
activation_74 (Activation)	(None, 12, 12, 192)	0	batch_normalizat
conv2d_71 (Conv2D)	(None, 5, 5, 320)	552,960	activation_70[0]
conv2d_75 (Conv2D)	(None, 5, 5, 192)	331,776	activation_74[0]
batch_normalization_71 (BatchNormalization)	(None, 5, 5, 320)	960	conv2d_71[0][0]
batch_normalization_75 (BatchNormalization)	(None, 5, 5, 192)	576	conv2d_75[0][0]
activation_71 (Activation)	(None, 5, 5, 320)	0	batch_normalizat
activation_75 (Activation)	(None, 5, 5, 192)	0	batch_normalizat
max_pooling2d_3 (MaxPooling2D)	(None, 5, 5, 768)	0	mixed7[0][0]
mixed8 (Concatenate)	(None, 5, 5, 1280)	0	activation_71[0] activation_75[0] max_pooling2d_3[
conv2d_80 (Conv2D)	(None, 5, 5, 448)	573,440	mixed8[0][0]
batch_normalization_80 (BatchNormalization)	(None, 5, 5, 448)	1,344	conv2d_80[0][0]
activation_80 (Activation)	(None, 5, 5, 448)	0	batch_normalizat
conv2d_77 (Conv2D)	(None, 5, 5, 384)	491,520	mixed8[0][0]
conv2d_81 (Conv2D)	(None, 5, 5, 384)	1,548,288	activation_80[0]

batch_normalization_77 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_77[0][0]
batch_normalization_81 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_81[0][0]
activation_77 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_81 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
conv2d_78 (Conv2D)	(None, 5, 5, 384)	442,368	activation_77[0]
conv2d_79 (Conv2D)	(None, 5, 5, 384)	442,368	activation_77[0]
conv2d_82 (Conv2D)	(None, 5, 5, 384)	442,368	activation_81[0]
conv2d_83 (Conv2D)	(None, 5, 5, 384)	442,368	activation_81[0]
average_pooling2d_7 (AveragePooling2D)	(None, 5, 5, 1280)	0	mixed8[0][0]
conv2d_76 (Conv2D)	(None, 5, 5, 320)	409,600	mixed8[0][0]
batch_normalization_78 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_78[0][0]
batch_normalization_79 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_79[0][0]
batch_normalization_82 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_82[0][0]
batch_normalization_83 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_83[0][0]
conv2d_84 (Conv2D)	(None, 5, 5, 192)	245,760	average_pooling
batch_normalization_76 (BatchNormalization)	(None, 5, 5, 320)	960	conv2d_76[0][0]
activation_78 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_79 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_82 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_83 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
batch_normalization_84 (BatchNormalization)	(None, 5, 5, 192)	576	conv2d_84[0][0]
activation_76	(None, 5, 5, 320)	0	batch normalizat

(Activation)			
mixed9_0 (Concatenate)	(None, 5, 5, 768)	0	activation_78[0] activation_79[0]
concatenate (Concatenate)	(None, 5, 5, 768)	0	activation_82[0] activation_83[0]
activation_84 (Activation)	(None, 5, 5, 192)	0	batch_normalizat
mixed9 (Concatenate)	(None, 5, 5, 2048)	0	activation_76[0] mixed9_0[0][0], concatenate[0][0] activation_84[0]
conv2d_89 (Conv2D)	(None, 5, 5, 448)	917,504	mixed9[0][0]
batch_normalization_89 (BatchNormalization)	(None, 5, 5, 448)	1,344	conv2d_89[0][0]
activation_89 (Activation)	(None, 5, 5, 448)	0	batch_normalizat
conv2d_86 (Conv2D)	(None, 5, 5, 384)	786,432	mixed9[0][0]
conv2d_90 (Conv2D)	(None, 5, 5, 384)	1,548,288	activation_89[0]
batch_normalization_86 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_86[0][0]
batch_normalization_90 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_90[0][0]
activation_86 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_90 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
conv2d_87 (Conv2D)	(None, 5, 5, 384)	442,368	activation_86[0]
conv2d_88 (Conv2D)	(None, 5, 5, 384)	442,368	activation_86[0]
conv2d_91 (Conv2D)	(None, 5, 5, 384)	442,368	activation_90[0]
conv2d_92 (Conv2D)	(None, 5, 5, 384)	442,368	activation_90[0]
average_pooling2d_8 (AveragePooling2D)	(None, 5, 5, 2048)	0	mixed9[0][0]
conv2d_85 (Conv2D)	(None, 5, 5, 320)	655,360	mixed9[0][0]
batch_normalization_87 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_87[0][0]
batch_normalization_88	(None, 5, 5, 384)	1,152	conv2d_88[0][0]

(BatchNormalization)			
batch_normalization_91 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_91[0][0]
batch_normalization_92 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_92[0][0]
conv2d_93 (Conv2D)	(None, 5, 5, 192)	393,216	average_pooling
batch_normalization_85 (BatchNormalization)	(None, 5, 5, 320)	960	conv2d_85[0][0]
activation_87 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_88 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_91 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
activation_92 (Activation)	(None, 5, 5, 384)	0	batch_normalizat
batch_normalization_93 (BatchNormalization)	(None, 5, 5, 192)	576	conv2d_93[0][0]
activation_85 (Activation)	(None, 5, 5, 320)	0	batch_normalizat

```
# Use the Image Data Generator to import the images from the dataset
from tensorflow.keras.preprocessing.image import ImageDataGenerator
train_datagen = ImageDataGenerator(rescale = 1./255,
                                    shear_range = 0.2,
                                    zoom_range = 0.2,
                                    horizontal_flip = True)

test_datagen = ImageDataGenerator(rescale = 1./255)
#no flip and zoom for test dataset

# Make sure you provide the same target size as initialized for the image size
training_set = train_datagen.flow_from_directory('/content/Data/train',
                                                target_size = (224, 224),
                                                batch_size = 32,
                                                class_mode = 'categorical')
```

→ Found 613 images belonging to 4 classes.

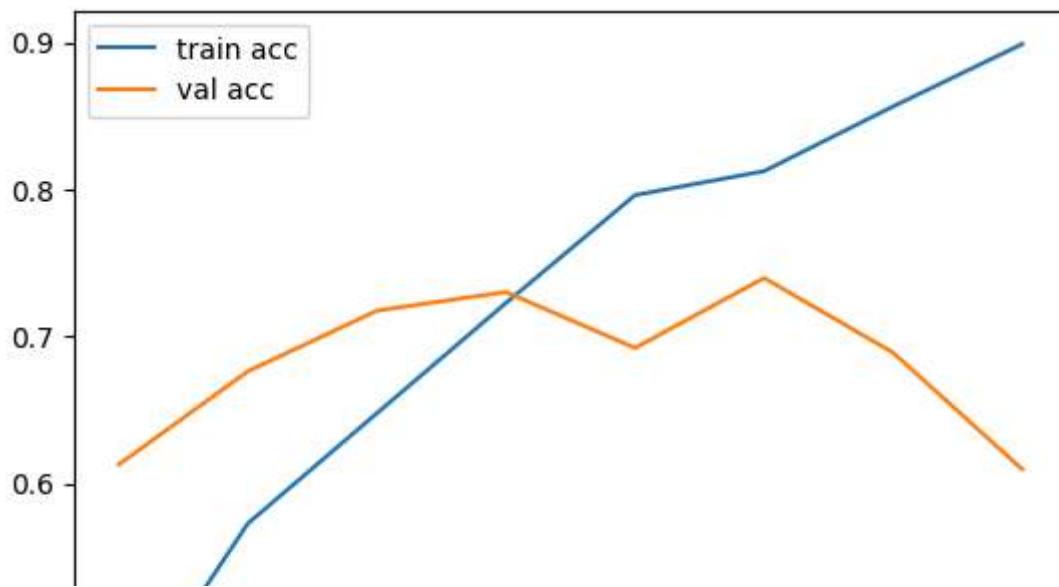
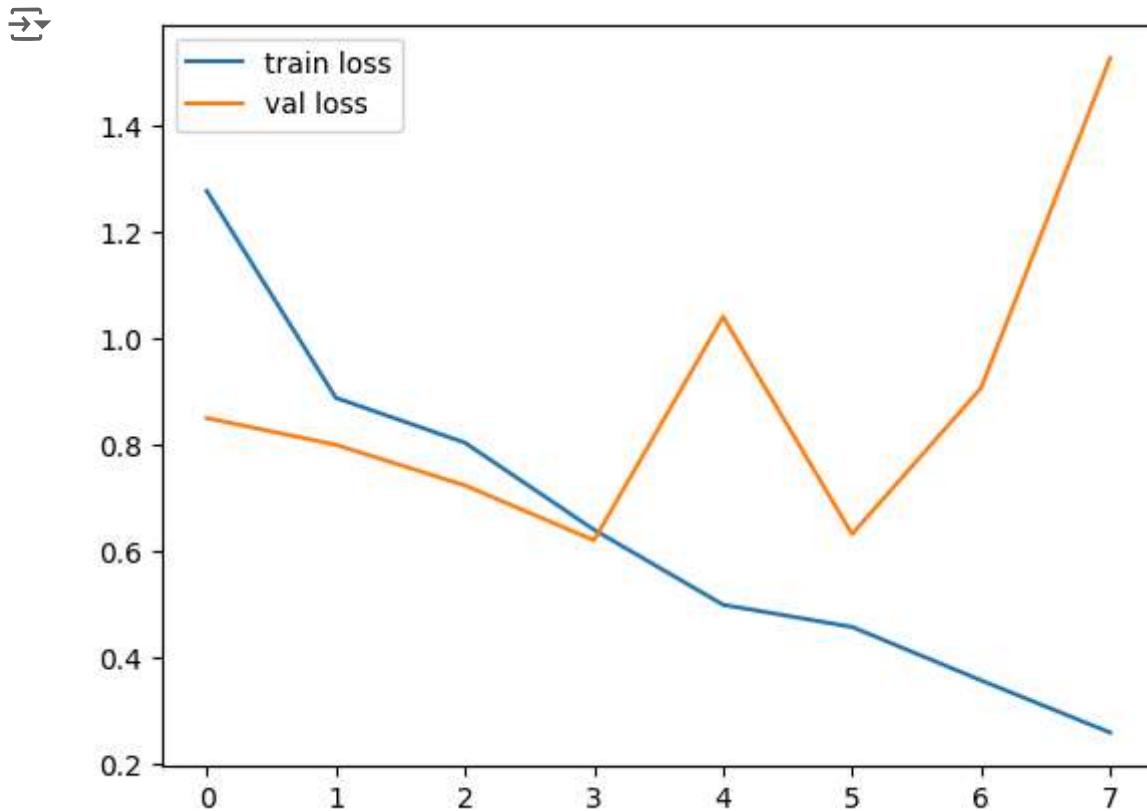
```
# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

# fit the model
# Run the cell. It will take some time to execute
r = model.fit(
    training_set,
    validation_data=test_set,
    epochs=8
)

→ Epoch 1/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:128s 6s/step - accuracy: 0.3666 - loss: 1.4680 - val_accuracy: 0.3666
Epoch 2/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:110s 5s/step - accuracy: 0.5810 - loss: 0.9007 - val_accuracy: 0.5810
Epoch 3/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:110s 5s/step - accuracy: 0.6334 - loss: 0.8111 - val_accuracy: 0.6334
Epoch 4/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:142s 5s/step - accuracy: 0.7030 - loss: 0.6906 - val_accuracy: 0.7030
Epoch 5/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:116s 6s/step - accuracy: 0.7872 - loss: 0.4919 - val_accuracy: 0.7872
Epoch 6/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:148s 6s/step - accuracy: 0.8237 - loss: 0.4424 - val_accuracy: 0.8237
Epoch 7/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:112s 5s/step - accuracy: 0.8608 - loss: 0.3629 - val_accuracy: 0.8608
Epoch 8/8
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:110s 5s/step - accuracy: 0.9078 - loss: 0.2622 - val_accuracy: 0.9078

# plot the loss
plt.plot(r.history['loss'], label='train loss')
plt.plot(r.history['val_loss'], label='val loss')
plt.legend()
plt.show()
plt.savefig('LossVal_loss')

# plot the accuracy
plt.plot(r.history['accuracy'], label='train acc')
plt.plot(r.history['val_accuracy'], label='val acc')
plt.legend()
plt.show()
plt.savefig('AccVal_acc')
```



```
import numpy as np
```

```
# Assuming 'model' is your trained model and 'test_set' is your test dataset
y_pred = model.predict(test_set) # Predict on the test set
```