

In [1]:

```
!pip install -q keras
```

In [2]:

```
!pip install pyunpack
```

Collecting pyunpack

Downloading pyunpack-0.2.2-py2.py3-none-any.whl (3.8 kB)

Collecting easyprocess

Downloading EasyProcess-0.3-py2.py3-none-any.whl (7.9 kB)

Collecting entrypoint2

Downloading entrypoint2-0.2.4-py3-none-any.whl (6.2 kB)

Installing collected packages: entrypoint2, easyprocess, pyunpack

Successfully installed easyprocess-0.3 entrypoint2-0.2.4 pyunpack-0.2.2

In [3]:

```
# TensorFlow and tf.keras
```

```
import tensorflow as tf
```

```
import numpy as np
```

In [4]:

```
pip install efficientnet
```

Collecting efficientnet

Downloading efficientnet-1.1.1-py3-none-any.whl (18 kB)

Requirement already satisfied: scikit-image in /opt/conda/lib/python3.7/site-packages (from efficientnet) (0.18.1)

Collecting keras-applications<=1.0.8,>=1.0.7

Downloading Keras_Applications-1.0.8-py3-none-any.whl (50 kB)

|██| 50 kB 647 kB/s eta 0:00:01

Requirement already satisfied: numpy>=1.9.1 in /opt/conda/lib/python3.7/site-packages (from keras-applications<=1.0.8,>=1.0.7->efficientnet) (1.19.5)

Requirement already satisfied: h5py in /opt/conda/lib/python3.7/site-packages (from keras-applications<=1.0.8,>=1.0.7->efficientnet) (2.10.0)

Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages (from h5py->keras-applications<=1.0.8,>=1.0.7->efficientnet) (1.15.0)

Requirement already satisfied: PyWavelets>=1.1.1 in /opt/conda/lib/python3.7/site-packages (from scikit-image->efficientnet) (1.1.1)

Requirement already satisfied: scipy>=1.0.1 in /opt/conda/lib/python3.7/site-packages (from scikit-image->efficientnet) (1.5.4)

Requirement already satisfied: networkx>=2.0 in /opt/conda/lib/python3.7/site-packages (from scikit-image->efficientnet) (2.5)

Requirement already satisfied: matplotlib!=3.0.0,>=2.0.0 in /opt/conda/lib/python3.7/site-packages (from scikit-image->efficientnet) (3.4.0)

Requirement already satisfied: tifffile>=2019.7.26 in /opt/conda/lib/python3.7/site-packages (from scikit-image->efficientnet) (2021.3.17)

Requirement already satisfied: imageio>=2.3.0 in /opt/conda/lib/python3.7/site-packages (from scikit-image->efficientnet) (2.9.0)

Requirement already satisfied: pillow!=7.1.0,!>=7.1.1,>=4.3.0 in /opt/conda/lib/python3.7/site-packages (from scikit-image->efficientnet) (7.2.0)

Requirement already satisfied: cycler>=0.10 in /opt/conda/lib/python3.7/site-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet) (0.10.0)

Requirement already satisfied: python-dateutil>=2.7 in /opt/conda/lib/python3.7/site-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet) (2.8.1)

Requirement already satisfied: kiwisolver>=1.0.1 in /opt/conda/lib/python3.7/site-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet) (1.3.1)

Requirement already satisfied: pyparsing>=2.2.1 in /opt/conda/lib/python3.7/site-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet) (2.4.7)

Requirement already satisfied: decorator>=4.3.0 in /opt/conda/lib/python3.7/site-packages (from networkx>=2.0->scikit-image->efficientnet) (4.4.2)

Installing collected packages: keras-applications, efficientnet

Successfully installed efficientnet-1.1.1 keras-applications-1.0.8

Note: you may need to restart the kernel to use updated packages.

In [5]:

```
from tensorflow.keras.layers import Input, Lambda, Dense, Flatten
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
import numpy as np
```

In [6]:

```
import scipy.io as sio
import os
batch_size = 32
input_shape = (240,240)
train_dir = '../input/stanford-car-dataset-by-classes-folder/car_data/car_data/train'
test_dir = '../input/stanford-car-dataset-by-classes-folder/car_data/car_data/test'
train_datagen = ImageDataGenerator(
    rescale=1./255,
    shear_range=0.2,
    rotation_range=20.,
    width_shift_range=0.1,
    height_shift_range=0.1,
    zoom_range=[0.9, 1.25],
    brightness_range=[0.5, 1.5],
    horizontal_flip=True)

test_datagen = ImageDataGenerator(rescale=1./255)
train_generator=train_datagen.flow_from_directory(train_dir,
class_mode="categorical",
target_size=input_shape,
batch_size=batch_size)
validation_generator=test_datagen.flow_from_directory(test_dir,
class_mode="categorical",
target_size=input_shape,
batch_size=batch_size)
```

Found 8144 images belonging to 196 classes.
Found 8041 images belonging to 196 classes.

In [7]:

```
import os
from keras.models import Model
from keras.optimizers import Adam
from keras.layers import Dense, Dropout, Flatten
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
import tensorflow as tf
import keras
from keras.models import load_model
from keras.layers import Dropout, Dense, GlobalAveragePooling2D
from keras.optimizers import Adam
```

In [8]:

```
from keras.layers import BatchNormalization
from keras import optimizers
import efficientnet.keras as efn
from keras.preprocessing import image
from keras.layers import Input
from keras import backend as K
from keras.models import model_from_json
from keras.optimizers import Nadam
from keras.layers import Dropout
from keras.layers.convolutional import AveragePooling2D

base_model = efn.EfficientNetB3(weights='imagenet', include_top=False)
#add a global spatial average pooling layer
x = base_model.output
```

```
x = GlobalAveragePooling2D() (x)
x = Dense(64,activation='relu') (x)
x = Dropout(0.4) (x)
x = Dense(128,activation='relu') (x)
x=BatchNormalization() (x)
predictions = Dense(196,activation='softmax') (x)
model = Model(inputs=base_model.input, outputs=predictions)
model.compile(optimizer='adam',
loss='categorical_crossentropy',metrics=['accuracy'])
model.summary()
```

Downloading data from https://github.com/Callidior/keras-applications/releases/download/efficientnet/efficientnet-b3_weights_tf_dim_ordering_tf_kernels_autoaugment_notop.h5
44113920/44107200 [=====] - 1s 0us/step
Model: "model"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_1 (InputLayer)	[(None, None, None, 0		
=====			
stem_conv (Conv2D)	(None, None, None, 4 1080		input_1[0][0]
=====			
stem_bn (BatchNormalization)	(None, None, None, 4 160		stem_conv[0][0]
=====			
stem_activation (Activation)	(None, None, None, 4 0		stem_bn[0][0]
=====			
block1a_dwconv (DepthwiseConv2D)	(None, None, None, 4 360		stem_activation[0][0]
=====			
block1a_bn (BatchNormalization)	(None, None, None, 4 160		block1a_dwconv[0][0]
=====			
block1a_activation (Activation)	(None, None, None, 4 0		block1a_bn[0][0]
=====			
block1a_se_squeeze (GlobalAvera	(None, 40)	0	block1a_activation[0][0]
=====			
block1a_se_reshape (Reshape)	(None, 1, 1, 40)	0	block1a_se_squeeze[0][0]
=====			
block1a_se_reduce (Conv2D)	(None, 1, 1, 10)	410	block1a_se_reshape[0][0]
=====			
block1a_se_expand (Conv2D)	(None, 1, 1, 40)	440	block1a_se_reduce[0][0]
=====			
block1a_se_excite (Multiply)	(None, None, None, 4 0		block1a_activation[0][0] block1a_se_expand[0][0]
=====			
block1a_project_conv (Conv2D)	(None, None, None, 2 960		block1a_se_excite[0][0]

block1a_project_bn	(BatchNormal	(None, None, None, 2	96	block1a_project_conv[0][0]
block1b_dwconv	(DepthwiseConv2D	(None, None, None, 2	216	block1a_project_bn[0][0]
block1b_bn	(BatchNormalization)	(None, None, None, 2	96	block1b_dwconv[0][0]
block1b_activation	(Activation)	(None, None, None, 2	0	block1b_bn[0][0]
block1b_se_squeeze	(GlobalAvera	(None, 24)	0	block1b_activation[0][0]
block1b_se_reshape	(Reshape)	(None, 1, 1, 24)	0	block1b_se_squeeze[0][0]
block1b_se_reduce	(Conv2D)	(None, 1, 1, 6)	150	block1b_se_reshape[0][0]
block1b_se_expand	(Conv2D)	(None, 1, 1, 24)	168	block1b_se_reduce[0][0]
block1b_se_excite	(Multiply)	(None, None, None, 2	0	block1b_activation[0][0]
				block1b_se_expand[0][0]
block1b_project_conv	(Conv2D)	(None, None, None, 2	576	block1b_se_excite[0][0]
block1b_project_bn	(BatchNormal	(None, None, None, 2	96	block1b_project_conv[0][0]
block1b_drop	(FixedDropout)	(None, None, None, 2	0	block1b_project_bn[0][0]
block1b_add	(Add)	(None, None, None, 2	0	block1b_drop[0][0]
				block1a_project_bn[0][0]
block2a_expand_conv	(Conv2D)	(None, None, None, 1	3456	block1b_add[0][0]
block2a_expand_bn	(BatchNormali	(None, None, None, 1	576	block2a_expand_conv[0][0]
block2a_expand_activation	(Acti	(None, None, None, 1	0	block2a_expand_bn[0][0]
block2a_dwconv	(DepthwiseConv2D	(None, None, None, 1	1296	block2a_expand_activatio

n[0][0]

block2a_bn (BatchNormalization)	(None, None, None, 1 576	block2a_dwconv[0][0]
block2a_activation (Activation)	(None, None, None, 1 0	block2a_bn[0][0]
block2a_se_squeeze (GlobalAvera	(None, 144) 0	block2a_activation[0][0]
block2a_se_reshape (Reshape)	(None, 1, 1, 144) 0	block2a_se_squeeze[0][0]
block2a_se_reduce (Conv2D)	(None, 1, 1, 6) 870	block2a_se_reshape[0][0]
block2a_se_expand (Conv2D)	(None, 1, 1, 144) 1008	block2a_se_reduce[0][0]
block2a_se_excite (Multiply)	(None, None, None, 1 0]]	block2a_activation[0][0] block2a_se_expand[0][0]
block2a_project_conv (Conv2D)	(None, None, None, 3 4608	block2a_se_excite[0][0]
block2a_project_bn (BatchNormal	(None, None, None, 3 128 0]	block2a_project_conv[0][0]
block2b_expand_conv (Conv2D)	(None, None, None, 1 6144	block2a_project_bn[0][0]
block2b_expand_bn (BatchNormali	(None, None, None, 1 768]	block2b_expand_conv[0][0]
block2b_expand_activation (Acti	(None, None, None, 1 0	block2b_expand_bn[0][0]
block2b_dwconv (DepthwiseConv2D	(None, None, None, 1 1728 n[0][0]	block2b_expand_activatio
block2b_bn (BatchNormalization)	(None, None, None, 1 768	block2b_dwconv[0][0]
block2b_activation (Activation)	(None, None, None, 1 0	block2b_bn[0][0]
block2b_se_squeeze (GlobalAvera	(None, 192) 0	block2b_activation[0][0]
block2b_se_reshape (Reshape)	(None, 1, 1, 192) 0	block2b_se_squeeze[0][0]

block2b_se_reduce (Conv2D)	(None, 1, 1, 8)	1544	block2b_se_reshape[0][0]
block2b_se_expand (Conv2D)	(None, 1, 1, 192)	1728	block2b_se_reduce[0][0]
block2b_se_excite (Multiply)	(None, None, None, 1 0]		block2b_activation[0][0] block2b_se_expand[0][0]
block2b_project_conv (Conv2D)	(None, None, None, 3 6144		block2b_se_excite[0][0]
block2b_project_bn (BatchNormal	(None, None, None, 3 128 0]		block2b_project_conv[0][0]
block2b_drop (FixedDropout)	(None, None, None, 3 0]		block2b_project_bn[0][0]
block2b_add (Add)	(None, None, None, 3 0 0]		block2b_drop[0][0] block2a_project_bn[0][0]
block2c_expand_conv (Conv2D)	(None, None, None, 1 6144		block2b_add[0][0]
block2c_expand_bn (BatchNormali	(None, None, None, 1 768]		block2c_expand_conv[0][0]
block2c_expand_activation (Acti	(None, None, None, 1 0		block2c_expand_bn[0][0]
block2c_dwconv (DepthwiseConv2D	(None, None, None, 1 1728 n[0][0]		block2c_expand_activatio
block2c_bn (BatchNormalization)	(None, None, None, 1 768		block2c_dwconv[0][0]
block2c_activation (Activation)	(None, None, None, 1 0		block2c_bn[0][0]
block2c_se_squeeze (GlobalAvera	(None, 192)	0	block2c_activation[0][0]
block2c_se_reshape (Reshape)	(None, 1, 1, 192)	0	block2c_se_squeeze[0][0]
block2c_se_reduce (Conv2D)	(None, 1, 1, 8)	1544	block2c_se_reshape[0][0]
block2c_se_expand (Conv2D)	(None, 1, 1, 192)	1728	block2c_se_reduce[0][0]

block2c_se_excite (Multiply)	(None, None, None, 1 0	block2c_activation[0][0]
]		block2c_se_expand[0][0]
]		
block2c_project_conv (Conv2D)	(None, None, None, 3 6144	block2c_se_excite[0][0]
block2c_project_bn (BatchNormal	(None, None, None, 3 128	block2c_project_conv[0][
0]		0]
block2c_drop (FixedDropout)	(None, None, None, 3 0	block2c_project_bn[0][0]
]		
block2c_add (Add)	(None, None, None, 3 0	block2c_drop[0][0]
		block2b_add[0][0]
block3a_expand_conv (Conv2D)	(None, None, None, 1 6144	block2c_add[0][0]
block3a_expand_bn (BatchNormali	(None, None, None, 1 768	block3a_expand_conv[0][0]
]		
block3a_expand_activation (Acti	(None, None, None, 1 0	block3a_expand_bn[0][0]
block3a_dwconv (DepthwiseConv2D	(None, None, None, 1 4800	block3a_expand_activatio
n[0][0]		n[0][0]
block3a_bn (BatchNormalization)	(None, None, None, 1 768	block3a_dwconv[0][0]
block3a_activation (Activation)	(None, None, None, 1 0	block3a_bn[0][0]
block3a_se_squeeze (GlobalAvera	(None, 192)	0
		block3a_activation[0][0]
block3a_se_reshape (Reshape)	(None, 1, 1, 192)	0
		block3a_se_squeeze[0][0]
block3a_se_reduce (Conv2D)	(None, 1, 1, 8)	1544
		block3a_se_reshape[0][0]
block3a_se_expand (Conv2D)	(None, 1, 1, 192)	1728
		block3a_se_reduce[0][0]
block3a_se_excite (Multiply)	(None, None, None, 1 0	block3a_activation[0][0]
]		block3a_se_expand[0][0]
]		
block3a_project_conv (Conv2D)	(None, None, None, 4 9216	block3a_se_excite[0][0]

block3a_project_bn	(BatchNormal	(None, None, None, 4	192	block3a_project_conv[0][0]
block3b_expand_conv	(Conv2D)	(None, None, None, 2	13824	block3a_project_bn[0][0]
block3b_expand_bn	(BatchNormali	(None, None, None, 2	1152	block3b_expand_conv[0][0]
block3b_expand_activation	(Acti	(None, None, None, 2	0	block3b_expand_bn[0][0]
block3b_dwconv	(DepthwiseConv2D	(None, None, None, 2	7200	block3b_expand_activatio
n[0][0]				
block3b_bn	(BatchNormalization)	(None, None, None, 2	1152	block3b_dwconv[0][0]
block3b_activation	(Activation)	(None, None, None, 2	0	block3b_bn[0][0]
block3b_se_squeeze	(GlobalAvera	(None, 288)	0	block3b_activation[0][0]
block3b_se_reshape	(Reshape)	(None, 1, 1, 288)	0	block3b_se_squeeze[0][0]
block3b_se_reduce	(Conv2D)	(None, 1, 1, 12)	3468	block3b_se_reshape[0][0]
block3b_se_expand	(Conv2D)	(None, 1, 1, 288)	3744	block3b_se_reduce[0][0]
block3b_se_excite	(Multiply)	(None, None, None, 2	0	block3b_activation[0][0]
]				block3b_se_expand[0][0]
]				
block3b_project_conv	(Conv2D)	(None, None, None, 4	13824	block3b_se_excite[0][0]
block3b_project_bn	(BatchNormal	(None, None, None, 4	192	block3b_project_conv[0][0]
0]				
block3b_drop	(FixedDropout)	(None, None, None, 4	0	block3b_project_bn[0][0]
]				
block3b_add	(Add)	(None, None, None, 4	0	block3b_drop[0][0]
0]				block3a_project_bn[0][0]
block3c_expand_conv	(Conv2D)	(None, None, None, 2	13824	block3b_add[0][0]

block3c_expand_bn (BatchNormali	(None, None, None, 2 1152		block3c_expand_conv[0][0]
block3c_expand_activation (Acti	(None, None, None, 2 0		block3c_expand_bn[0][0]
block3c_dwconv (DepthwiseConv2D	(None, None, None, 2 7200		block3c_expand_activatio
n[0][0]			
block3c_bn (BatchNormalization)	(None, None, None, 2 1152		block3c_dwconv[0][0]
block3c_activation (Activation)	(None, None, None, 2 0		block3c_bn[0][0]
block3c_se_squeeze (GlobalAvera	(None, 288)	0	block3c_activation[0][0]
block3c_se_reshape (Reshape)	(None, 1, 1, 288)	0	block3c_se_squeeze[0][0]
block3c_se_reduce (Conv2D)	(None, 1, 1, 12)	3468	block3c_se_reshape[0][0]
block3c_se_expand (Conv2D)	(None, 1, 1, 288)	3744	block3c_se_reduce[0][0]
block3c_se_excite (Multiply)	(None, None, None, 2 0		block3c_activation[0][0]
			block3c_se_expand[0][0]
block3c_project_conv (Conv2D)	(None, None, None, 4 13824		block3c_se_excite[0][0]
block3c_project_bn (BatchNormal	(None, None, None, 4 192		block3c_project_conv[0][
0]			
block3c_drop (FixedDropout)	(None, None, None, 4 0		block3c_project_bn[0][0]
block3c_add (Add)	(None, None, None, 4 0		block3c_drop[0][0]
			block3b_add[0][0]
block4a_expand_conv (Conv2D)	(None, None, None, 2 13824		block3c_add[0][0]
block4a_expand_bn (BatchNormali	(None, None, None, 2 1152		block4a_expand_conv[0][0]
block4a_expand_activation (Acti	(None, None, None, 2 0		block4a_expand_bn[0][0]

block4a_dwconv (DepthwiseConv2D)	(None, None, None, 2 2592	block4a_expand_activation[0][0]
block4a_bn (BatchNormalization)	(None, None, None, 2 1152	block4a_dwconv[0][0]
block4a_activation (Activation)	(None, None, None, 2 0	block4a_bn[0][0]
block4a_se_squeeze (GlobalAveragePooling2D)	(None, 288) 0	block4a_activation[0][0]
block4a_se_reshape (Reshape)	(None, 1, 1, 288) 0	block4a_se_squeeze[0][0]
block4a_se_reduce (Conv2D)	(None, 1, 1, 12) 3468	block4a_se_reshape[0][0]
block4a_se_expand (Conv2D)	(None, 1, 1, 288) 3744	block4a_se_reduce[0][0]
block4a_se_excite (Multiply)	(None, None, None, 2 0	block4a_activation[0][0]
		block4a_se_expand[0][0]
block4a_project_conv (Conv2D)	(None, None, None, 9 27648	block4a_se_excite[0][0]
block4a_project_bn (BatchNormalization)	(None, None, None, 9 384	block4a_project_conv[0][0]
block4b_expand_conv (Conv2D)	(None, None, None, 5 55296	block4a_project_bn[0][0]
block4b_expand_bn (BatchNormalization)	(None, None, None, 5 2304	block4b_expand_conv[0][0]
block4b_expand_activation (Activation)	(None, None, None, 5 0	block4b_expand_bn[0][0]
block4b_dwconv (DepthwiseConv2D)	(None, None, None, 5 5184	block4b_expand_activation[0][0]
block4b_bn (BatchNormalization)	(None, None, None, 5 2304	block4b_dwconv[0][0]
block4b_activation (Activation)	(None, None, None, 5 0	block4b_bn[0][0]
block4b_se_squeeze (GlobalAveragePooling2D)	(None, 576) 0	block4b_activation[0][0]

block4b_se_reshape (Reshape)	(None, 1, 1, 576)	0	block4b_se_squeeze[0][0]
block4b_se_reduce (Conv2D)	(None, 1, 1, 24)	13848	block4b_se_reshape[0][0]
block4b_se_expand (Conv2D)	(None, 1, 1, 576)	14400	block4b_se_reduce[0][0]
block4b_se_excite (Multiply)	(None, None, None, 5 0]		block4b_activation[0][0] block4b_se_expand[0][0]
block4b_project_conv (Conv2D)	(None, None, None, 9 55296		block4b_se_excite[0][0]
block4b_project_bn (BatchNormal	(None, None, None, 9 384		block4b_project_conv[0][
0]			
block4b_drop (FixedDropout)	(None, None, None, 9 0		block4b_project_bn[0][0]
]			
block4b_add (Add)	(None, None, None, 9 0		block4b_drop[0][0]
			block4a_project_bn[0][
0]			
block4c_expand_conv (Conv2D)	(None, None, None, 5 55296		block4b_add[0][0]
block4c_expand_bn (BatchNormali	(None, None, None, 5 2304		block4c_expand_conv[0][0]
]			
block4c_expand_activation (Acti	(None, None, None, 5 0		block4c_expand_bn[0][0]
block4c_dwconv (DepthwiseConv2D	(None, None, None, 5 5184		block4c_expand_activatio
n[0][0]			
block4c_bn (BatchNormalization)	(None, None, None, 5 2304		block4c_dwconv[0][0]
block4c_activation (Activation)	(None, None, None, 5 0		block4c_bn[0][0]
block4c_se_squeeze (GlobalAvera	(None, 576)	0	block4c_activation[0][0]
block4c_se_reshape (Reshape)	(None, 1, 1, 576)	0	block4c_se_squeeze[0][0]
block4c_se_reduce (Conv2D)	(None, 1, 1, 24)	13848	block4c_se_reshape[0][0]

block4c_se_expand (Conv2D)	(None, 1, 1, 576)	14400	block4c_se_reduce[0][0]
block4c_se_excite (Multiply)	(None, None, None, 5 0		block4c_activation[0][0]
			block4c_se_expand[0][0]
block4c_project_conv (Conv2D)	(None, None, None, 9 55296		block4c_se_excite[0][0]
block4c_project_bn (BatchNormal	(None, None, None, 9 384		block4c_project_conv[0][0]
block4c_drop (FixedDropout)	(None, None, None, 9 0		block4c_project_bn[0][0]
block4c_add (Add)	(None, None, None, 9 0		block4c_drop[0][0]
			block4b_add[0][0]
block4d_expand_conv (Conv2D)	(None, None, None, 5 55296		block4c_add[0][0]
block4d_expand_bn (BatchNormali	(None, None, None, 5 2304		block4d_expand_conv[0][0]
block4d_expand_activation (Acti	(None, None, None, 5 0		block4d_expand_bn[0][0]
block4d_dwconv (DepthwiseConv2D	(None, None, None, 5 5184		block4d_expand_activatio
n[0][0]			n[0][0]
block4d_bn (BatchNormalization)	(None, None, None, 5 2304		block4d_dwconv[0][0]
block4d_activation (Activation)	(None, None, None, 5 0		block4d_bn[0][0]
block4d_se_squeeze (GlobalAvera	(None, 576)	0	block4d_activation[0][0]
block4d_se_reshape (Reshape)	(None, 1, 1, 576)	0	block4d_se_squeeze[0][0]
block4d_se_reduce (Conv2D)	(None, 1, 1, 24)	13848	block4d_se_reshape[0][0]
block4d_se_expand (Conv2D)	(None, 1, 1, 576)	14400	block4d_se_reduce[0][0]
block4d_se_excite (Multiply)	(None, None, None, 5 0		block4d_activation[0][0]
			block4d_se_expand[0][0]

]		
<hr/>		
block4d_project_conv (Conv2D)	(None, None, None, 9 55296	block4d_se_excite[0][0]
<hr/>		
block4d_project_bn (BatchNormal	(None, None, None, 9 384	block4d_project_conv[0][
0]		
<hr/>		
block4d_drop (FixedDropout)	(None, None, None, 9 0	block4d_project_bn[0][0]
<hr/>		
block4d_add (Add)	(None, None, None, 9 0	block4d_drop[0][0]
<hr/>		
		block4c_add[0][0]
<hr/>		
block4e_expand_conv (Conv2D)	(None, None, None, 5 55296	block4d_add[0][0]
<hr/>		
block4e_expand_bn (BatchNormali	(None, None, None, 5 2304	block4e_expand_conv[0][0]
<hr/>		
block4e_expand_activation (Acti	(None, None, None, 5 0	block4e_expand_bn[0][0]
<hr/>		
block4e_dwconv (DepthwiseConv2D	(None, None, None, 5 5184	block4e_expand_activatio
n[0][0]		
<hr/>		
block4e_bn (BatchNormalization)	(None, None, None, 5 2304	block4e_dwconv[0][0]
<hr/>		
block4e_activation (Activation)	(None, None, None, 5 0	block4e_bn[0][0]
<hr/>		
block4e_se_squeeze (GlobalAvera	(None, 576)	0
<hr/>		
block4e_se_reshape (Reshape)	(None, 1, 1, 576)	0
<hr/>		
block4e_se_reduce (Conv2D)	(None, 1, 1, 24)	13848
<hr/>		
block4e_se_expand (Conv2D)	(None, 1, 1, 576)	14400
<hr/>		
block4e_se_excite (Multiply)	(None, None, None, 5 0	block4e_activation[0][0]
<hr/>		
		block4e_se_expand[0][0]
<hr/>		
block4e_project_conv (Conv2D)	(None, None, None, 9 55296	block4e_se_excite[0][0]
<hr/>		
block4e_project_bn (BatchNormal	(None, None, None, 9 384	block4e_project_conv[0][
]		

0]

block4e_drop (FixedDropout)	(None, None, None, 9 0	block4e_project_bn[0][0]
block4e_add (Add)	(None, None, None, 9 0	block4e_drop[0][0] block4d_add[0][0]
block5a_expand_conv (Conv2D)	(None, None, None, 5 55296	block4e_add[0][0]
block5a_expand_bn (BatchNormali	(None, None, None, 5 2304	block5a_expand_conv[0][0]
block5a_expand_activation (Acti	(None, None, None, 5 0	block5a_expand_bn[0][0]
block5a_dwconv (DepthwiseConv2D	(None, None, None, 5 14400	block5a_expand_activatio
n[0][0]		
block5a_bn (BatchNormalization)	(None, None, None, 5 2304	block5a_dwconv[0][0]
block5a_activation (Activation)	(None, None, None, 5 0	block5a_bn[0][0]
block5a_se_squeeze (GlobalAvera	(None, 576)	0
		block5a_activation[0][0]
block5a_se_reshape (Reshape)	(None, 1, 1, 576)	0
		block5a_se_squeeze[0][0]
block5a_se_reduce (Conv2D)	(None, 1, 1, 24)	13848
		block5a_se_reshape[0][0]
block5a_se_expand (Conv2D)	(None, 1, 1, 576)	14400
		block5a_se_reduce[0][0]
block5a_se_excite (Multiply)	(None, None, None, 5 0	block5a_activation[0][0]
]		block5a_se_expand[0][0]
]		
block5a_project_conv (Conv2D)	(None, None, None, 1 78336	block5a_se_excite[0][0]
block5a_project_bn (BatchNormal	(None, None, None, 1 544	block5a_project_conv[0][
0]		0]
block5b_expand_conv (Conv2D)	(None, None, None, 8 110976	block5a_project_bn[0][0]
block5b_expand_bn (BatchNormali	(None, None, None, 8 3264	block5b_expand_conv[0][0]

]				
block5b_expand_activation	(Activation)	(None, None, None, 8 0	block5b_expand_bn[0][0]	
block5b_dwconv	(DepthwiseConv2D)	(None, None, None, 8 20400	block5b_expand_activation[0][0]	
block5b_bn	(BatchNormalization)	(None, None, None, 8 3264	block5b_dwconv[0][0]	
block5b_activation	(Activation)	(None, None, None, 8 0	block5b_bn[0][0]	
block5b_se_squeeze	(GlobalAveragePooling2D)	(None, 816)	0	block5b_activation[0][0]
block5b_se_reshape	(Reshape)	(None, 1, 1, 816)	0	block5b_se_squeeze[0][0]
block5b_se_reduce	(Conv2D)	(None, 1, 1, 34)	27778	block5b_se_reshape[0][0]
block5b_se_expand	(Conv2D)	(None, 1, 1, 816)	28560	block5b_se_reduce[0][0]
block5b_se_excite	(Multiply)	(None, None, None, 8 0	0	block5b_activation[0][0]
]				
]				
block5b_project_conv	(Conv2D)	(None, None, None, 1 110976	0	block5b_se_excite[0][0]
block5b_project_bn	(BatchNormalization)	(None, None, None, 1 544	0	block5b_project_conv[0][0]
block5b_drop	(FixedDropout)	(None, None, None, 1 0	0	block5b_project_bn[0][0]
block5b_add	(Add)	(None, None, None, 1 0	0	block5b_drop[0][0]
0]				
block5c_expand_conv	(Conv2D)	(None, None, None, 8 110976	0	block5b_add[0][0]
block5c_expand_bn	(BatchNormalization)	(None, None, None, 8 3264	0	block5c_expand_conv[0][0]
block5c_expand_activation	(Activation)	(None, None, None, 8 0	0	block5c_expand_bn[0][0]
block5c_dwconv	(DepthwiseConv2D)	(None, None, None, 8 20400	0	block5c_expand_activation[0][0]

n[0][0]

block5c_bn (BatchNormalization)	(None, None, None, 8 3264	block5c_dwconv[0][0]
block5c_activation (Activation)	(None, None, None, 8 0	block5c_bn[0][0]
block5c_se_squeeze (GlobalAvera	(None, 816) 0	block5c_activation[0][0]
block5c_se_reshape (Reshape)	(None, 1, 1, 816) 0	block5c_se_squeeze[0][0]
block5c_se_reduce (Conv2D)	(None, 1, 1, 34) 27778	block5c_se_reshape[0][0]
block5c_se_expand (Conv2D)	(None, 1, 1, 816) 28560	block5c_se_reduce[0][0]
block5c_se_excite (Multiply)	(None, None, None, 8 0	block5c_activation[0][0]
		block5c_se_expand[0][0]
block5c_project_conv (Conv2D)	(None, None, None, 1 110976	block5c_se_excite[0][0]
block5c_project_bn (BatchNormal	(None, None, None, 1 544	block5c_project_conv[0][0]
block5c_drop (FixedDropout)	(None, None, None, 1 0	block5c_project_bn[0][0]
block5c_add (Add)	(None, None, None, 1 0	block5c_drop[0][0]
		block5b_add[0][0]
block5d_expand_conv (Conv2D)	(None, None, None, 8 110976	block5c_add[0][0]
block5d_expand_bn (BatchNormali	(None, None, None, 8 3264	block5d_expand_conv[0][0]
block5d_expand_activation (Acti	(None, None, None, 8 0	block5d_expand_bn[0][0]
block5d_dwconv (DepthwiseConv2D	(None, None, None, 8 20400	block5d_expand_activatio
n[0][0]		
block5d_bn (BatchNormalization)	(None, None, None, 8 3264	block5d_dwconv[0][0]
block5d_activation (Activation)	(None, None, None, 8 0	block5d_bn[0][0]

block5d_se_squeeze	(GlobalAveragePooling2D)	(None, 816)	0	block5d_activation[0][0]
block5d_se_reshape	(Reshape)	(None, 1, 1, 816)	0	block5d_se_squeeze[0][0]
block5d_se_reduce	(Conv2D)	(None, 1, 1, 34)	27778	block5d_se_reshape[0][0]
block5d_se_expand	(Conv2D)	(None, 1, 1, 816)	28560	block5d_se_reduce[0][0]
block5d_se_excite	(Multiply)	(None, None, None, 8 0]		block5d_activation[0][0] block5d_se_expand[0][0]
block5d_project_conv	(Conv2D)	(None, None, None, 1 110976		block5d_se_excite[0][0]
block5d_project_bn	(BatchNormalization)	(None, None, None, 1 544 0]		block5d_project_conv[0][0]
block5d_drop	(FixedDropout)	(None, None, None, 1 0]		block5d_project_bn[0][0]
block5d_add	(Add)	(None, None, None, 1 0		block5d_drop[0][0] block5c_add[0][0]
block5e_expand_conv	(Conv2D)	(None, None, None, 8 110976		block5d_add[0][0]
block5e_expand_bn	(BatchNormalization)	(None, None, None, 8 3264 0]		block5e_expand_conv[0][0]
block5e_expand_activation	(Activation)	(None, None, None, 8 0		block5e_expand_bn[0][0]
block5e_dwconv	(DepthwiseConv2D)	(None, None, None, 8 20400 n[0][0]		block5e_expand_activation[0][0]
block5e_bn	(BatchNormalization)	(None, None, None, 8 3264		block5e_dwconv[0][0]
block5e_activation	(Activation)	(None, None, None, 8 0		block5e_bn[0][0]
block5e_se_squeeze	(GlobalAveragePooling2D)	(None, 816)	0	block5e_activation[0][0]
block5e_se_reshape	(Reshape)	(None, 1, 1, 816)	0	block5e_se_squeeze[0][0]

block5e_se_reduce (Conv2D)	(None, 1, 1, 34)	27778	block5e_se_reshape[0][0]
block5e_se_expand (Conv2D)	(None, 1, 1, 816)	28560	block5e_se_reduce[0][0]
block5e_se_excite (Multiply)	(None, None, None, 8 0]		block5e_activation[0][0] block5e_se_expand[0][0]
block5e_project_conv (Conv2D)	(None, None, None, 1 110976		block5e_se_excite[0][0]
block5e_project_bn (BatchNormal	(None, None, None, 1 544		block5e_project_conv[0][0]
block5e_drop (FixedDropout)	(None, None, None, 1 0]		block5e_project_bn[0][0]
block5e_add (Add)	(None, None, None, 1 0		block5e_drop[0][0] block5d_add[0][0]
block6a_expand_conv (Conv2D)	(None, None, None, 8 110976		block5e_add[0][0]
block6a_expand_bn (BatchNormali	(None, None, None, 8 3264		block6a_expand_conv[0][0]
block6a_expand_activation (Acti	(None, None, None, 8 0		block6a_expand_bn[0][0]
block6a_dwconv (DepthwiseConv2D	(None, None, None, 8 20400		block6a_expand_activatio
n[0][0]			
block6a_bn (BatchNormalization)	(None, None, None, 8 3264		block6a_dwconv[0][0]
block6a_activation (Activation)	(None, None, None, 8 0		block6a_bn[0][0]
block6a_se_squeeze (GlobalAvera	(None, 816)	0	block6a_activation[0][0]
block6a_se_reshape (Reshape)	(None, 1, 1, 816)	0	block6a_se_squeeze[0][0]
block6a_se_reduce (Conv2D)	(None, 1, 1, 34)	27778	block6a_se_reshape[0][0]
block6a_se_expand (Conv2D)	(None, 1, 1, 816)	28560	block6a_se_reduce[0][0]

block6a_se_excite (Multiply)	(None, None, None, 8 0		block6a_activation[0][0]
]			block6a_se_expand[0][0]
]			
block6a_project_conv (Conv2D)	(None, None, None, 2 189312		block6a_se_excite[0][0]
block6a_project_bn (BatchNormal	(None, None, None, 2 928		block6a_project_conv[0][
0]			0]
block6b_expand_conv (Conv2D)	(None, None, None, 1 322944		block6a_project_bn[0][0]
block6b_expand_bn (BatchNormali	(None, None, None, 1 5568		block6b_expand_conv[0][0
]]
block6b_expand_activation (Acti	(None, None, None, 1 0		block6b_expand_bn[0][0]
block6b_dwconv (DepthwiseConv2D	(None, None, None, 1 34800		block6b_expand_activatio
n[0][0]			n[0][0]
block6b_bn (BatchNormalization)	(None, None, None, 1 5568		block6b_dwconv[0][0]
block6b_activation (Activation)	(None, None, None, 1 0		block6b_bn[0][0]
block6b_se_squeeze (GlobalAvera	(None, 1392)	0	block6b_activation[0][0]
block6b_se_reshape (Reshape)	(None, 1, 1, 1392)	0	block6b_se_squeeze[0][0]
block6b_se_reduce (Conv2D)	(None, 1, 1, 58)	80794	block6b_se_reshape[0][0]
block6b_se_expand (Conv2D)	(None, 1, 1, 1392)	82128	block6b_se_reduce[0][0]
block6b_se_excite (Multiply)	(None, None, None, 1 0		block6b_activation[0][0]
]			block6b_se_expand[0][0
]]
block6b_project_conv (Conv2D)	(None, None, None, 2 322944		block6b_se_excite[0][0]
block6b_project_bn (BatchNormal	(None, None, None, 2 928		block6b_project_conv[0][
0]			0]
block6b_drop (FixedDropout)	(None, None, None, 2 0		block6b_project_bn[0][0

]		
block6b_add (Add)	(None, None, None, 2 0	block6b_drop[0][0]
		block6a_project_bn[0][0]
block6c_expand_conv (Conv2D)	(None, None, None, 1 322944	block6b_add[0][0]
block6c_expand_bn (BatchNormali	(None, None, None, 1 5568	block6c_expand_conv[0][0]
block6c_expand_activation (Acti	(None, None, None, 1 0	block6c_expand_bn[0][0]
block6c_dwconv (DepthwiseConv2D	(None, None, None, 1 34800	block6c_expand_activatio
n[0][0]		
block6c_bn (BatchNormalization)	(None, None, None, 1 5568	block6c_dwconv[0][0]
block6c_activation (Activation)	(None, None, None, 1 0	block6c_bn[0][0]
block6c_se_squeeze (GlobalAvera	(None, 1392) 0	block6c_activation[0][0]
block6c_se_reshape (Reshape)	(None, 1, 1, 1392) 0	block6c_se_squeeze[0][0]
block6c_se_reduce (Conv2D)	(None, 1, 1, 58) 80794	block6c_se_reshape[0][0]
block6c_se_expand (Conv2D)	(None, 1, 1, 1392) 82128	block6c_se_reduce[0][0]
block6c_se_excite (Multiply)	(None, None, None, 1 0	block6c_activation[0][0]
		block6c_se_expand[0][0]
block6c_project_conv (Conv2D)	(None, None, None, 2 322944	block6c_se_excite[0][0]
block6c_project_bn (BatchNormal	(None, None, None, 2 928	block6c_project_conv[0][0]
0]		
block6c_drop (FixedDropout)	(None, None, None, 2 0	block6c_project_bn[0][0]
block6c_add (Add)	(None, None, None, 2 0	block6c_drop[0][0]
		block6b_add[0][0]

block6d_expand_conv (Conv2D)	(None, None, None, 1 322944	block6c_add[0][0]
block6d_expand_bn (BatchNormali]	(None, None, None, 1 5568	block6d_expand_conv[0][0]
block6d_expand_activation (Acti	(None, None, None, 1 0	block6d_expand_bn[0][0]
block6d_dwconv (DepthwiseConv2D n[0][0]	(None, None, None, 1 34800	block6d_expand_activatio
block6d_bn (BatchNormalization)	(None, None, None, 1 5568	block6d_dwconv[0][0]
block6d_activation (Activation)	(None, None, None, 1 0	block6d_bn[0][0]
block6d_se_squeeze (GlobalAvera	(None, 1392) 0	block6d_activation[0][0]
block6d_se_reshape (Reshape)	(None, 1, 1, 1392) 0	block6d_se_squeeze[0][0]
block6d_se_reduce (Conv2D)	(None, 1, 1, 58) 80794	block6d_se_reshape[0][0]
block6d_se_expand (Conv2D)	(None, 1, 1, 1392) 82128	block6d_se_reduce[0][0]
block6d_se_excite (Multiply)]]	(None, None, None, 1 0	block6d_activation[0][0] block6d_se_expand[0][0]
block6d_project_conv (Conv2D)	(None, None, None, 2 322944	block6d_se_excite[0][0]
block6d_project_bn (BatchNormal 0]	(None, None, None, 2 928	block6d_project_conv[0][
block6d_drop (FixedDropout)]	(None, None, None, 2 0	block6d_project_bn[0][0]
block6d_add (Add)	(None, None, None, 2 0	block6d_drop[0][0] block6c_add[0][0]
block6e_expand_conv (Conv2D)	(None, None, None, 1 322944	block6d_add[0][0]
block6e_expand_bn (BatchNormali]	(None, None, None, 1 5568	block6e_expand_conv[0][0]

block6e_expand_activation	(Activation)	(None, None, None, 1 0	0	block6e_expand_bn[0][0]
block6e_dwconv	(DepthwiseConv2D)	(None, None, None, 1 34800	0	block6e_expand_activation[0][0]
block6e_bn	(BatchNormalization)	(None, None, None, 1 5568	0	block6e_dwconv[0][0]
block6e_activation	(Activation)	(None, None, None, 1 0	0	block6e_bn[0][0]
block6e_se_squeeze	(GlobalAveragePooling2D)	(None, 1392)	0	block6e_activation[0][0]
block6e_se_reshape	(Reshape)	(None, 1, 1, 1392)	0	block6e_se_squeeze[0][0]
block6e_se_reduce	(Conv2D)	(None, 1, 1, 58)	80794	block6e_se_reshape[0][0]
block6e_se_expand	(Conv2D)	(None, 1, 1, 1392)	82128	block6e_se_reduce[0][0]
block6e_se_excite	(Multiply)	(None, None, None, 1 0	0	block6e_activation[0][0]
				block6e_se_expand[0][0]
block6e_project_conv	(Conv2D)	(None, None, None, 2 322944	0	block6e_se_excite[0][0]
block6e_project_bn	(BatchNormalization)	(None, None, None, 2 928	0	block6e_project_conv[0][0]
block6e_drop	(FixedDropout)	(None, None, None, 2 0	0	block6e_project_bn[0][0]
block6e_add	(Add)	(None, None, None, 2 0	0	block6e_drop[0][0]
				block6d_add[0][0]
block6f_expand_conv	(Conv2D)	(None, None, None, 1 322944	0	block6e_add[0][0]
block6f_expand_bn	(BatchNormalization)	(None, None, None, 1 5568	0	block6f_expand_conv[0][0]
block6f_expand_activation	(Activation)	(None, None, None, 1 0	0	block6f_expand_bn[0][0]
block6f_dwconv	(DepthwiseConv2D)	(None, None, None, 1 34800	0	block6f_expand_activation[0][0]

block6f_bn (BatchNormalization)	(None, None, None, 1 5568		block6f_dwconv[0][0]
block6f_activation (Activation)	(None, None, None, 1 0		block6f_bn[0][0]
block6f_se_squeeze (GlobalAvera	(None, 1392)	0	block6f_activation[0][0]
block6f_se_reshape (Reshape)	(None, 1, 1, 1392)	0	block6f_se_squeeze[0][0]
block6f_se_reduce (Conv2D)	(None, 1, 1, 58)	80794	block6f_se_reshape[0][0]
block6f_se_expand (Conv2D)	(None, 1, 1, 1392)	82128	block6f_se_reduce[0][0]
block6f_se_excite (Multiply)	(None, None, None, 1 0		block6f_activation[0][0]
			block6f_se_expand[0][0]
block6f_project_conv (Conv2D)	(None, None, None, 2 322944		block6f_se_excite[0][0]
block6f_project_bn (BatchNormal	(None, None, None, 2 928		block6f_project_conv[0][0]
block6f_drop (FixedDropout)	(None, None, None, 2 0		block6f_project_bn[0][0]
block6f_add (Add)	(None, None, None, 2 0		block6f_drop[0][0]
			block6e_add[0][0]
block7a_expand_conv (Conv2D)	(None, None, None, 1 322944		block6f_add[0][0]
block7a_expand_bn (BatchNormali	(None, None, None, 1 5568		block7a_expand_conv[0][0]
block7a_expand_activation (Acti	(None, None, None, 1 0		block7a_expand_bn[0][0]
block7a_dwconv (DepthwiseConv2D	(None, None, None, 1 12528		block7a_expand_activatio
n[0][0]			
block7a_bn (BatchNormalization)	(None, None, None, 1 5568		block7a_dwconv[0][0]
block7a_activation (Activation)	(None, None, None, 1 0		block7a_bn[0][0]

block7a_se_squeeze (GlobalAveragePooling2D)	(None, 1392)	0	block7a_activation[0][0]
block7a_se_reshape (Reshape)	(None, 1, 1, 1392)	0	block7a_se_squeeze[0][0]
block7a_se_reduce (Conv2D)	(None, 1, 1, 58)	80794	block7a_se_reshape[0][0]
block7a_se_expand (Conv2D)	(None, 1, 1, 1392)	82128	block7a_se_reduce[0][0]
block7a_se_excite (Multiply)	(None, None, None, 1 0]		block7a_activation[0][0] block7a_se_expand[0][0]
block7a_project_conv (Conv2D)	(None, None, None, 3 534528		block7a_se_excite[0][0]
block7a_project_bn (BatchNormalization)	(None, None, None, 3 1536 0]		block7a_project_conv[0][0]
block7b_expand_conv (Conv2D)	(None, None, None, 2 884736		block7a_project_bn[0][0]
block7b_expand_bn (BatchNormalization)	(None, None, None, 2 9216]		block7b_expand_conv[0][0]
block7b_expand_activation (Activation)	(None, None, None, 2 0		block7b_expand_bn[0][0]
block7b_dwconv (DepthwiseConv2D)	(None, None, None, 2 20736 n[0][0]		block7b_expand_activation[0][0]
block7b_bn (BatchNormalization)	(None, None, None, 2 9216		block7b_dwconv[0][0]
block7b_activation (Activation)	(None, None, None, 2 0		block7b_bn[0][0]
block7b_se_squeeze (GlobalAveragePooling2D)	(None, 2304)	0	block7b_activation[0][0]
block7b_se_reshape (Reshape)	(None, 1, 1, 2304)	0	block7b_se_squeeze[0][0]
block7b_se_reduce (Conv2D)	(None, 1, 1, 96)	221280	block7b_se_reshape[0][0]
block7b_se_expand (Conv2D)	(None, 1, 1, 2304)	223488	block7b_se_reduce[0][0]
block7b_se_excite (Multiply)	(None, None, None, 2 0		block7b_activation[0][0]

		block7b_se_expand[0][0]
<hr/>		
block7b_project_conv (Conv2D)	(None, None, None, 3 884736	block7b_se_excite[0][0]
<hr/>		
block7b_project_bn (BatchNormal	(None, None, None, 3 1536	block7b_project_conv[0][0]
<hr/>		
block7b_drop (FixedDropout)	(None, None, None, 3 0	block7b_project_bn[0][0]
<hr/>		
block7b_add (Add)	(None, None, None, 3 0	block7b_drop[0][0]
		block7a_project_bn[0][0]
<hr/>		
top_conv (Conv2D)	(None, None, None, 1 589824	block7b_add[0][0]
<hr/>		
top_bn (BatchNormalization)	(None, None, None, 1 6144	top_conv[0][0]
<hr/>		
top_activation (Activation)	(None, None, None, 1 0	top_bn[0][0]
<hr/>		
global_average_pooling2d (Globa	(None, 1536)	0
		top_activation[0][0]
<hr/>		
dense (Dense)	(None, 64)	98368
d[0][0]		global_average_pooling2
<hr/>		
dropout (Dropout)	(None, 64)	0
		dense[0][0]
<hr/>		
dense_1 (Dense)	(None, 128)	8320
		dropout[0][0]
<hr/>		
batch_normalization (BatchNorma	(None, 128)	512
		dense_1[0][0]
<hr/>		
dense_2 (Dense)	(None, 196)	25284
		batch_normalization[0][0]
<hr/>		
=====		
=====		
Total params: 10,916,012		
Trainable params: 10,828,460		
Non-trainable params: 87,552		

In [9]:

```
history = model.fit_generator(generator=train_generator,
                             steps_per_epoch=train_generator.samples // batch_size + 1,
                             validation_data=validation_generator,
                             validation_steps=validation_generator.samples // batch_size + 1,
                             epochs=44,
```

verbose=1)

/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/training.py:1844: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.

warnings.warn("`Model.fit_generator` is deprecated and "

Epoch 1/44

255/255 [=====] - 386s 1s/step - loss: 5.4769 - accuracy: 0.0108
- val_loss: 6.0013 - val_accuracy: 0.0111

Epoch 2/44

255/255 [=====] - 271s 1s/step - loss: 5.0018 - accuracy: 0.0138
- val_loss: 4.5464 - val_accuracy: 0.0464

Epoch 3/44

255/255 [=====] - 270s 1s/step - loss: 4.4713 - accuracy: 0.0464
- val_loss: 3.8690 - val_accuracy: 0.0853

Epoch 4/44

255/255 [=====] - 270s 1s/step - loss: 3.9238 - accuracy: 0.0870
- val_loss: 3.3079 - val_accuracy: 0.1607

Epoch 5/44

255/255 [=====] - 271s 1s/step - loss: 3.4513 - accuracy: 0.1382
- val_loss: 3.1647 - val_accuracy: 0.1899

Epoch 6/44

255/255 [=====] - 272s 1s/step - loss: 3.0269 - accuracy: 0.2014
- val_loss: 2.4945 - val_accuracy: 0.3008

Epoch 7/44

255/255 [=====] - 269s 1s/step - loss: 2.6966 - accuracy: 0.2629
- val_loss: 2.0841 - val_accuracy: 0.3987

Epoch 8/44

255/255 [=====] - 270s 1s/step - loss: 2.4128 - accuracy: 0.3111
- val_loss: 1.8780 - val_accuracy: 0.4555

Epoch 9/44

255/255 [=====] - 271s 1s/step - loss: 2.1737 - accuracy: 0.3773
- val_loss: 1.8214 - val_accuracy: 0.4659

Epoch 10/44

255/255 [=====] - 270s 1s/step - loss: 1.9513 - accuracy: 0.4294
- val_loss: 1.5732 - val_accuracy: 0.5207

Epoch 11/44

255/255 [=====] - 273s 1s/step - loss: 1.7282 - accuracy: 0.4784
- val_loss: 1.5095 - val_accuracy: 0.5570

Epoch 12/44

255/255 [=====] - 273s 1s/step - loss: 1.6249 - accuracy: 0.5080
- val_loss: 1.2958 - val_accuracy: 0.6065

Epoch 13/44

255/255 [=====] - 273s 1s/step - loss: 1.4515 - accuracy: 0.5664
- val_loss: 1.2453 - val_accuracy: 0.6370

Epoch 14/44

255/255 [=====] - 275s 1s/step - loss: 1.3613 - accuracy: 0.5864
- val_loss: 1.1674 - val_accuracy: 0.6576

Epoch 15/44

255/255 [=====] - 271s 1s/step - loss: 1.2394 - accuracy: 0.6172
- val_loss: 1.1409 - val_accuracy: 0.6589

Epoch 16/44

255/255 [=====] - 269s 1s/step - loss: 1.1850 - accuracy: 0.6344
- val_loss: 0.8893 - val_accuracy: 0.7403

Epoch 17/44

255/255 [=====] - 270s 1s/step - loss: 1.0733 - accuracy: 0.6723
- val_loss: 0.9205 - val_accuracy: 0.7316

Epoch 18/44

255/255 [=====] - 270s 1s/step - loss: 0.9966 - accuracy: 0.6889
- val_loss: 0.8804 - val_accuracy: 0.7452

Epoch 19/44

255/255 [=====] - 271s 1s/step - loss: 0.9521 - accuracy: 0.7039
- val_loss: 1.0198 - val_accuracy: 0.7228

Epoch 20/44

255/255 [=====] - 273s 1s/step - loss: 0.9134 - accuracy: 0.7171
- val_loss: 0.8622 - val_accuracy: 0.7526

Epoch 21/44

255/255 [=====] - 267s 1s/step - loss: 0.7933 - accuracy: 0.7441
- val_loss: 0.9027 - val_accuracy: 0.7443

Epoch 22/44

255/255 [=====] - 272s 1s/step - loss: 0.7958 - accuracy: 0.7545
- val_loss: 0.8800 - val_accuracy: 0.7571

```

- val_loss: 0.8899 - val_accuracy: 0.7571
Epoch 23/44
255/255 [=====] - 270s 1s/step - loss: 0.7184 - accuracy: 0.7845
- val_loss: 0.9136 - val_accuracy: 0.7591
Epoch 24/44
255/255 [=====] - 267s 1s/step - loss: 0.7583 - accuracy: 0.7683
- val_loss: 0.9105 - val_accuracy: 0.7592
Epoch 25/44
255/255 [=====] - 267s 1s/step - loss: 0.6585 - accuracy: 0.7967
- val_loss: 0.8833 - val_accuracy: 0.7589
Epoch 26/44
255/255 [=====] - 267s 1s/step - loss: 0.6493 - accuracy: 0.7977
- val_loss: 0.8671 - val_accuracy: 0.7720
Epoch 27/44
255/255 [=====] - 270s 1s/step - loss: 0.6122 - accuracy: 0.8090
- val_loss: 0.8545 - val_accuracy: 0.7854
Epoch 28/44
255/255 [=====] - 267s 1s/step - loss: 0.6251 - accuracy: 0.8130
- val_loss: 1.0215 - val_accuracy: 0.7473
Epoch 29/44
255/255 [=====] - 269s 1s/step - loss: 0.5973 - accuracy: 0.8212
- val_loss: 0.7614 - val_accuracy: 0.8029
Epoch 30/44
255/255 [=====] - 267s 1s/step - loss: 0.5710 - accuracy: 0.8226
- val_loss: 0.7301 - val_accuracy: 0.8176
Epoch 31/44
255/255 [=====] - 269s 1s/step - loss: 0.5052 - accuracy: 0.8378
- val_loss: 0.8619 - val_accuracy: 0.7878
Epoch 32/44
255/255 [=====] - 268s 1s/step - loss: 0.5200 - accuracy: 0.8454
- val_loss: 0.7229 - val_accuracy: 0.8197
Epoch 33/44
255/255 [=====] - 268s 1s/step - loss: 0.4780 - accuracy: 0.8522
- val_loss: 0.8689 - val_accuracy: 0.8041
Epoch 34/44
255/255 [=====] - 268s 1s/step - loss: 0.4740 - accuracy: 0.8511
- val_loss: 0.7307 - val_accuracy: 0.8193
Epoch 35/44
255/255 [=====] - 268s 1s/step - loss: 0.4268 - accuracy: 0.8606
- val_loss: 0.8601 - val_accuracy: 0.8009
Epoch 36/44
255/255 [=====] - 267s 1s/step - loss: 0.4971 - accuracy: 0.8508
- val_loss: 0.7954 - val_accuracy: 0.8182
Epoch 37/44
255/255 [=====] - 267s 1s/step - loss: 0.4422 - accuracy: 0.8669
- val_loss: 0.7726 - val_accuracy: 0.8223
Epoch 38/44
255/255 [=====] - 267s 1s/step - loss: 0.4227 - accuracy: 0.8664
- val_loss: 0.7990 - val_accuracy: 0.8116
Epoch 39/44
255/255 [=====] - 267s 1s/step - loss: 0.4177 - accuracy: 0.8726
- val_loss: 0.6469 - val_accuracy: 0.8458
Epoch 40/44
255/255 [=====] - 267s 1s/step - loss: 0.4154 - accuracy: 0.8725
- val_loss: 0.8475 - val_accuracy: 0.8128
Epoch 41/44
255/255 [=====] - 266s 1s/step - loss: 0.4229 - accuracy: 0.8713
- val_loss: 0.8232 - val_accuracy: 0.8204
Epoch 42/44
255/255 [=====] - 266s 1s/step - loss: 0.3811 - accuracy: 0.8837
- val_loss: 0.8157 - val_accuracy: 0.8291
Epoch 43/44
255/255 [=====] - 266s 1s/step - loss: 0.3951 - accuracy: 0.8831
- val_loss: 0.8122 - val_accuracy: 0.8195
Epoch 44/44
255/255 [=====] - 274s 1s/step - loss: 0.3932 - accuracy: 0.8873
- val_loss: 0.8031 - val_accuracy: 0.8179

```

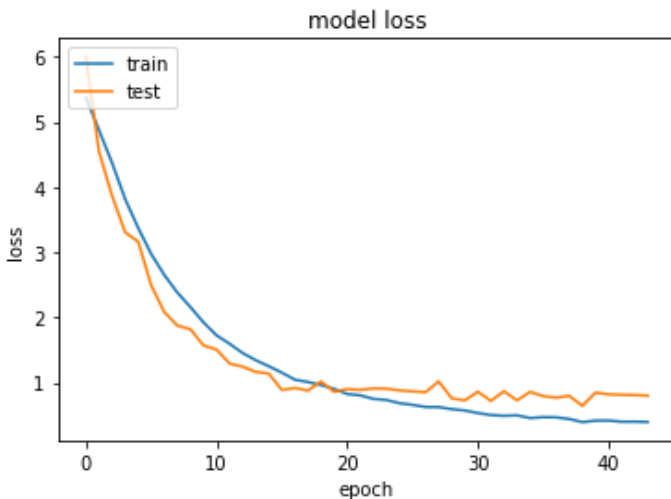
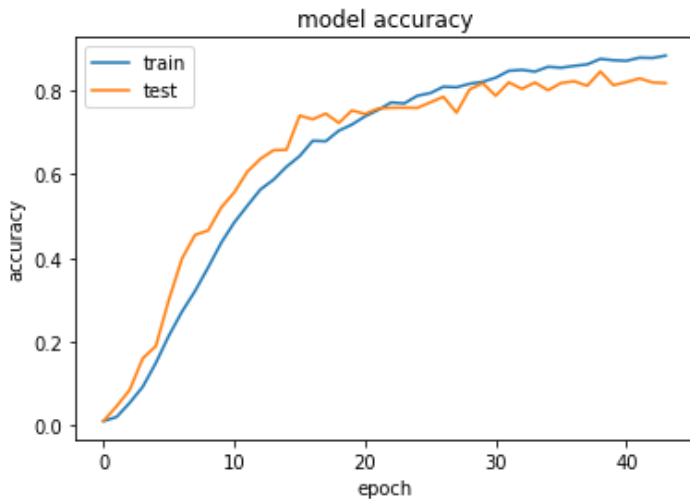
In [10]:

```

plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])

```

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



In [11]:

```
batch_size = 32
train_generator=train_datagen.flow_from_directory(train_dir,
                                                    class_mode="categorical",
                                                    target_size=input_shape,
                                                    batch_size=batch_size)

validation_generator=test_datagen.flow_from_directory(test_dir,
                                                       class_mode="categorical",
                                                       target_size=input_shape,
                                                       batch_size=batch_size)

for layer in model.layers:
    layer.trainable = True

model.compile(optimizer='sgd', loss='categorical_crossentropy', metrics=['accuracy'])
```

Found 8144 images belonging to 196 classes.
Found 8041 images belonging to 196 classes.

In [12]:

```
history = model.fit_generator(generator=train_generator,
                              steps_per_epoch=train_generator.samples // batch_size + 1,
                              validation_data=validation_generator,
                              validation_steps=validation_generator.samples // batch_size + 1,
                              epochs=24,

                              verbose=1)
```

Epoch 1/24

255/255 [=====] - 280s 1s/step - loss: 0.3325 - accuracy: 0.9031
- val_loss: 0.5643 - val_accuracy: 0.8708

Epoch 2/24

255/255 [=====] - 268s 1s/step - loss: 0.2836 - accuracy: 0.9132
- val_loss: 0.5346 - val_accuracy: 0.8749

Epoch 3/24

255/255 [=====] - 267s 1s/step - loss: 0.2581 - accuracy: 0.9202
- val_loss: 0.5224 - val_accuracy: 0.8768

Epoch 4/24

255/255 [=====] - 268s 1s/step - loss: 0.2359 - accuracy: 0.9285
- val_loss: 0.5063 - val_accuracy: 0.8797

Epoch 5/24

255/255 [=====] - 281s 1s/step - loss: 0.2168 - accuracy: 0.9340
- val_loss: 0.5011 - val_accuracy: 0.8822

Epoch 6/24

255/255 [=====] - 280s 1s/step - loss: 0.2154 - accuracy: 0.9357
- val_loss: 0.4939 - val_accuracy: 0.8830

Epoch 7/24

255/255 [=====] - 269s 1s/step - loss: 0.1917 - accuracy: 0.9413
- val_loss: 0.4883 - val_accuracy: 0.8843

Epoch 8/24

255/255 [=====] - 267s 1s/step - loss: 0.1987 - accuracy: 0.9411
- val_loss: 0.4793 - val_accuracy: 0.8870

Epoch 9/24

255/255 [=====] - 266s 1s/step - loss: 0.2022 - accuracy: 0.9396
- val_loss: 0.4780 - val_accuracy: 0.8887

Epoch 10/24

255/255 [=====] - 268s 1s/step - loss: 0.1889 - accuracy: 0.9427
- val_loss: 0.4780 - val_accuracy: 0.8883

Epoch 11/24

255/255 [=====] - 267s 1s/step - loss: 0.1839 - accuracy: 0.9430
- val_loss: 0.4793 - val_accuracy: 0.8901

Epoch 12/24

255/255 [=====] - 265s 1s/step - loss: 0.1786 - accuracy: 0.9461
- val_loss: 0.4751 - val_accuracy: 0.8884

Epoch 13/24

255/255 [=====] - 265s 1s/step - loss: 0.1711 - accuracy: 0.9494
- val_loss: 0.4721 - val_accuracy: 0.8903

Epoch 14/24

255/255 [=====] - 266s 1s/step - loss: 0.1716 - accuracy: 0.9466
- val_loss: 0.4679 - val_accuracy: 0.8901

Epoch 15/24

255/255 [=====] - 267s 1s/step - loss: 0.1654 - accuracy: 0.9502
- val_loss: 0.4689 - val_accuracy: 0.8914

Epoch 16/24

255/255 [=====] - 270s 1s/step - loss: 0.1575 - accuracy: 0.9507
- val_loss: 0.4672 - val_accuracy: 0.8916

Epoch 17/24

255/255 [=====] - 268s 1s/step - loss: 0.1823 - accuracy: 0.9457
- val_loss: 0.4666 - val_accuracy: 0.8924

Epoch 18/24

255/255 [=====] - 266s 1s/step - loss: 0.1619 - accuracy: 0.9509
- val_loss: 0.4641 - val_accuracy: 0.8923

Epoch 19/24

255/255 [=====] - 267s 1s/step - loss: 0.1735 - accuracy: 0.9501
- val_loss: 0.4650 - val_accuracy: 0.8914

Epoch 20/24

255/255 [=====] - 267s 1s/step - loss: 0.1626 - accuracy: 0.9498
- val_loss: 0.4639 - val_accuracy: 0.8928

Epoch 21/24

255/255 [=====] - 268s 1s/step - loss: 0.1715 - accuracy: 0.9425

```
- val_loss: 0.4620 - val_accuracy: 0.8940
Epoch 22/24
255/255 [=====] - 269s 1s/step - loss: 0.1578 - accuracy: 0.9495
- val_loss: 0.4631 - val_accuracy: 0.8935
Epoch 23/24
255/255 [=====] - 267s 1s/step - loss: 0.1619 - accuracy: 0.9525
- val_loss: 0.4642 - val_accuracy: 0.8933
Epoch 24/24
255/255 [=====] - 268s 1s/step - loss: 0.1432 - accuracy: 0.9578
- val_loss: 0.4617 - val_accuracy: 0.8942
```

In [16]:

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

In [18]:

```
from keras.models import load_model
```

In [20]:

```
new_model=load_model('Efficientnet_model.h5')
```

In [21]:

```
loss,acc=new_model.evaluate(validation_generator)
print(acc)
```

```
252/252 [=====] - 71s 274ms/step - loss: 0.4617 - accuracy: 0.89
42
0.8941673636436462
```

In [22]:

```
train_generator=train_datagen.flow_from_directory(train_dir,
                                                    class_mode="categorical",
                                                    target_size=input_shape,
                                                    batch_size=batch_size,shuffle=False)

validation_generator=test_datagen.flow_from_directory(test_dir,
                                                       class_mode="categorical",
                                                       target_size=input_shape,
                                                       batch_size=batch_size,shuffle=False)
```

Found 8144 images belonging to 196 classes.
Found 8041 images belonging to 196 classes.

In [24]:

```
Y_pred = model.predict_generator(validation_generator, validation_generator.samples //
batch_size+1)
y_pred = np.argmax(Y_pred, axis=1)
print('Confusion Matrix')
print(confusion_matrix(validation_generator.classes, y_pred))
print('Classification Report')

print(classification_report(validation_generator.classes, y_pred))
```

```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/training.py:1905: U
serWarning: `Model.predict_generator` is deprecated and will be removed in a future versi
on. Please use `Model.predict`, which supports generators.
  warnings.warn("`Model.predict_generator` is deprecated and "
```

Confusion Matrix

```
[[43  0  0 ...  0  0  0]
 [ 0 43  0 ...  0  0  0]
 [ 0  0 27 ...  0  0  0]
 ...
 [ 0  0  0 ... 37  0  0]
 [ 0  0  0 ...  0 41  0]
 [ 0  0  0 ...  1  0 36]]
```

Classification Report				
	precision	recall	f1-score	support
0	0.91	0.98	0.95	44
1	0.90	0.98	0.93	44
2	0.82	0.84	0.83	32
3	0.87	0.95	0.91	43
4	0.97	0.93	0.95	42
5	0.97	0.82	0.89	40
6	0.85	0.90	0.88	39
7	0.70	0.84	0.77	45
8	0.80	0.68	0.74	41
9	0.90	0.79	0.84	33
10	0.89	0.87	0.88	38
11	0.61	0.70	0.65	40
12	0.70	0.71	0.71	42
13	0.75	0.88	0.81	41
14	0.93	0.91	0.92	43
15	0.94	0.92	0.93	36
16	0.93	0.93	0.93	45
17	0.82	0.82	0.82	39
18	0.85	0.83	0.84	42
19	0.72	0.67	0.69	42
20	0.93	0.91	0.92	46
21	0.52	0.62	0.57	40
22	0.83	0.74	0.78	39
23	0.72	0.55	0.62	42
24	0.74	0.72	0.73	43
25	1.00	0.91	0.96	35
26	0.91	0.98	0.94	41
27	0.88	0.90	0.89	42
28	0.95	0.90	0.92	41
29	0.87	0.75	0.80	44
30	0.97	0.91	0.94	34
31	0.91	0.95	0.93	44
32	0.90	0.93	0.92	41
33	0.71	0.83	0.76	41
34	0.97	0.97	0.97	38
35	0.89	0.98	0.93	41
36	0.97	0.93	0.95	42
37	0.93	0.95	0.94	40
38	0.90	0.95	0.92	39
39	0.80	0.89	0.84	44
40	0.69	0.67	0.68	46
41	0.73	0.65	0.69	34
42	0.91	0.89	0.90	36
43	0.88	0.86	0.87	35
44	0.90	0.59	0.72	32
45	0.79	0.88	0.84	43
46	0.87	0.98	0.92	42
47	0.88	0.90	0.89	42
48	0.97	0.94	0.96	35
49	0.92	0.95	0.93	37
50	0.98	1.00	0.99	43
51	0.89	0.95	0.92	44
52	1.00	1.00	1.00	41
53	0.82	0.93	0.87	45
54	1.00	0.91	0.95	44
55	1.00	0.95	0.97	41
56	0.85	0.87	0.86	39
57	0.82	0.89	0.86	37
58	0.83	0.83	0.83	46
59	0.50	0.76	0.60	29
60	0.50	0.31	0.39	35
61	0.97	0.94	0.96	36
62	0.84	0.88	0.86	43
63	0.76	0.82	0.78	38
64	0.90	0.82	0.86	44
65	0.87	0.87	0.87	45
66	0.95	0.93	0.94	42
67	0.77	0.79	0.78	43
68	0.86	0.80	0.83	40

69	0.70	0.75	0.73	44
70	0.68	0.68	0.68	38
71	0.94	1.00	0.97	44
72	0.85	0.76	0.80	37
73	1.00	0.97	0.99	40
74	0.95	0.89	0.92	44
75	0.85	0.94	0.89	48
76	0.98	1.00	0.99	43
77	0.98	0.95	0.96	43
78	0.94	0.98	0.96	45
79	0.94	0.85	0.89	40
80	0.88	0.97	0.92	37
81	0.87	0.87	0.87	45
82	0.77	0.86	0.81	42
83	0.76	0.70	0.73	40
84	1.00	1.00	1.00	43
85	0.95	0.97	0.96	39
86	0.87	0.95	0.91	42
87	0.91	0.95	0.93	41
88	0.82	0.87	0.85	38
89	1.00	0.88	0.94	41
90	0.98	0.96	0.97	45
91	1.00	1.00	1.00	43
92	1.00	0.98	0.99	44
93	0.97	0.97	0.97	40
94	0.90	0.86	0.88	42
95	0.77	0.82	0.79	44
96	0.91	0.79	0.85	39
97	0.95	0.89	0.92	46
98	1.00	1.00	1.00	27
99	0.97	0.97	0.97	33
100	0.90	0.90	0.90	39
101	0.78	0.90	0.84	42
102	0.97	0.95	0.96	39
103	0.90	0.83	0.86	42
104	0.98	0.98	0.98	43
105	0.97	1.00	0.99	37
106	0.98	1.00	0.99	43
107	0.95	0.95	0.95	44
108	0.89	0.93	0.91	45
109	0.98	0.98	0.98	42
110	0.95	1.00	0.98	41
111	0.95	0.95	0.95	42
112	0.93	0.89	0.91	45
113	0.88	0.98	0.92	44
114	0.89	0.87	0.88	45
115	1.00	1.00	1.00	44
116	1.00	0.98	0.99	42
117	0.93	0.98	0.96	44
118	0.95	0.93	0.94	40
119	0.84	0.82	0.83	68
120	0.95	0.98	0.96	41
121	0.97	0.76	0.85	42
122	0.87	0.91	0.89	44
123	0.90	0.81	0.85	43
124	0.85	0.87	0.86	39
125	0.97	0.90	0.93	39
126	0.86	0.95	0.90	38
127	0.97	0.93	0.95	41
128	0.93	0.93	0.93	42
129	0.87	0.83	0.85	24
130	0.83	0.90	0.86	42
131	0.88	0.86	0.87	42
132	0.95	0.95	0.95	42
133	0.91	0.98	0.94	43
134	1.00	0.90	0.95	42
135	0.97	0.97	0.97	33
136	0.97	0.95	0.96	39
137	0.95	0.91	0.93	43
138	0.91	0.95	0.93	41
139	0.78	0.86	0.82	42
140	0.91	0.94	0.93	34

141	0.97	0.94	0.95	32
142	0.91	1.00	0.95	40
143	0.88	0.91	0.89	46
144	0.88	0.86	0.87	42
145	0.86	0.93	0.89	45
146	0.91	0.98	0.95	44
147	0.97	0.89	0.93	44
148	1.00	1.00	1.00	43
149	0.86	0.86	0.86	43
150	0.93	0.91	0.92	44
151	1.00	0.86	0.92	35
152	0.92	0.94	0.93	36
153	1.00	0.98	0.99	42
154	1.00	0.98	0.99	42
155	1.00	0.87	0.93	39
156	1.00	0.97	0.99	36
157	0.89	0.86	0.88	29
158	0.94	0.94	0.94	36
159	0.80	0.93	0.86	44
160	0.94	0.96	0.95	48
161	0.95	0.93	0.94	45
162	0.84	0.98	0.90	43
163	1.00	0.91	0.95	44
164	0.97	0.89	0.93	36
165	0.82	0.90	0.86	41
166	0.91	0.87	0.89	47
167	0.93	0.91	0.92	46
168	0.93	0.91	0.92	44
169	1.00	1.00	1.00	42
170	0.97	0.92	0.95	38
171	1.00	0.98	0.99	44
172	0.95	0.91	0.93	43
173	0.97	0.78	0.86	41
174	0.85	0.89	0.87	38
175	1.00	0.90	0.95	30
176	0.86	0.84	0.85	44
177	0.95	0.93	0.94	41
178	0.85	0.87	0.86	45
179	0.80	0.79	0.80	42
180	0.86	0.84	0.85	38
181	0.89	0.91	0.90	46
182	0.93	0.98	0.95	42
183	0.86	0.75	0.80	40
184	0.88	0.97	0.93	38
185	0.98	1.00	0.99	40
186	0.76	0.95	0.85	43
187	0.97	0.77	0.86	43
188	0.97	0.89	0.93	38
189	1.00	0.95	0.98	42
190	0.92	1.00	0.96	46
191	0.95	0.93	0.94	43
192	1.00	0.93	0.97	45
193	0.97	0.90	0.94	41
194	0.98	0.95	0.96	43
195	0.92	0.90	0.91	40

accuracy			0.89	8041
macro avg	0.90	0.89	0.89	8041
weighted avg	0.90	0.89	0.89	8041

In [25]:

```
cm=confusion_matrix(validation_generator.classes, y_pred)
```

In [26]:

```
def plot_confusion_matrix(cm, classes,
                           normalize=False,
                           title='Confusion matrix',
                           cmap=plt.cm.Blues):
```

```

"""
This function prints and plots the confusion matrix.
Normalization can be applied by setting `normalize=True`.
"""
if normalize:
    cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
    print("Normalized confusion matrix")
else:
    print('Confusion matrix, without normalization')

print(cm)
plt.imshow(cm, interpolation='nearest', cmap=cmap)
plt.title(title)
plt.colorbar()
# tick_marks = np.arange(len(classes))
# plt.xticks(tick_marks, classes, rotation=45)
# plt.yticks(tick_marks, classes)

# fmt = '.2f' if normalize else 'd'
# thresh = cm.max() / 2.
# for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
#     plt.text(j, i, format(cm[i, j], fmt),
#              horizontalalignment="center",
#              color="white" if cm[i, j] > thresh else "black")

plt.tight_layout()
plt.ylabel('True label')
plt.xlabel('Predicted label')

```

In [27]:

```

category_names = sorted(os.listdir('../input/stanford-car-dataset-by-classes-folder/car_data/car_data/test'))

```

In [28]:

```

plot_confusion_matrix(cm, category_names,
                      normalize=True,
                      title='Confusion matrix',
                      cmap=plt.cm.Blues)

```

Normalized confusion matrix

```

[[0.97727273 0.         0.         ... 0.         0.         0.         ]
 [0.         0.97727273 0.         ... 0.         0.         0.         ]
 [0.         0.         0.84375     ... 0.         0.         0.         ]
 ...
 [0.         0.         0.         ... 0.90243902 0.         0.         ]
 [0.         0.         0.         ... 0.         0.95348837 0.         ]
 [0.         0.         0.         ... 0.025       0.         0.9       ]]

```

