In [6]:

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

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?cli
ent_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleuserconten
t.com&redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%3Aoob&scope=email%20http
s%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdocs.test%20https%3A%2F%2Fwww.google
apis.com%2Fauth%2Fdrive%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdrive.
photos.readonly%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fpeopleapi.read
only&response_type=code

Enter your authorization code:
··········
Mounted at /content/drive
```

In [0]:

```
import numpy as np
import sklearn.metrics as metrics
import matplotlib.pyplot as plt
import h5py

from tensorflow.keras.callbacks import ModelCheckpoint,CSVLogger,LearningRateScheduler
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input
from tensorflow.keras.layers import Dense
from tensorflow.keras.layers import Flatten
from tensorflow.keras.layers import Conv2D
from tensorflow.keras.layers import BatchNormalization
from tensorflow.keras.layers import Activation
from tensorflow.keras.layers import AveragePooling2D
from tensorflow.keras.layers import add
from tensorflow.keras.layers import Dropout
from tensorflow.keras.regularizers import l2
from tensorflow.keras.utils import to_categorical
from tensorflow.keras import optimizers
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

In [0]:

```
#from google.colab import files
#uploaded = files.upload()
```

In [0]:

```
def implt(img):
    plt.figure()
    plt.imshow(img)
    plt.axis('off')
```

In [0]:

```
                          # Set up 'ggplot' style
plt.style.use('ggplot')     # if want to use the default style, set 'classic'
plt.rcParams['ytick.right']     = True
plt.rcParams['ytick.labelright']= True
plt.rcParams['ytick.left']      = False
plt.rcParams['ytick.labelleft'] = False
plt.rcParams['font.family']     = 'Arial'
```

In [14]:

```
def read_data_set(h5_file='out.h5'):
    with h5py.File(h5_file, 'r') as hf:
        X_train = hf['X_train'].value
        print('Read X_train: ', X_train.shape)

        y_train = hf['y_train'].value
        print('Read y_train: ', y_train.shape)

        X_test = hf['X_test'].value
        print('Read X_test: ', X_test.shape)

        y_test = hf['y_test'].value
        print('Read y_test: ', y_test.shape)

    return (X_train, y_train, X_test, y_test)

X_train_data, y_train_data, X_test_data, y_test_data = read_data_set(h5_file='/content/
drive/My Drive/Colab/ca2data.h5' )
```

```
Read X_train:  (2067, 128, 128, 3)
Read y_train:  (2067,)
Read X_test:  (1034, 128, 128, 3)
Read y_test:  (1034,)
```

In [0]:

```
#data            = cifar10.load_data()
(trDat, trLbl)  = X_train_data, y_train_data
(tsDat, tsLbl)  = X_test_data, y_test_data


                          # Convert the data into 'float32'
                          # Rescale the values from 0~255 to 0~1
trDat       = trDat.astype('float32')/255
tsDat       = tsDat.astype('float32')/255


                          # Retrieve the row size of each image
                          # Retrieve the column size of each image
imgrows     = trDat.shape[1]
imgclms     = trDat.shape[2]
channel     = trDat.shape[3]


                          # Perform one hot encoding on the labels
                          # Retrieve the number of classes in this problem
trLbl       = to_categorical(trLbl)
tsLbl       = to_categorical(tsLbl)
num_classes = tsLbl.shape[1]
```

In [16]:

```
                            # fix random seed for reproducibility
seed        = 42
np.random.seed(seed)

optmz       = optimizers.Adam(lr=0.001)
modelname   = 'PRMLS_CA2'
                            # define the deep learning model

def resLyr(inputs,
           numFilters=16,
           kernelSz=3,
           strides=1,
           activation='relu',
           batchNorm=True,
           convFirst=True,
           lyrName=None):
  convLyr = Conv2D(numFilters,
                   kernel_size=kernelSz,
                   strides=strides,
                   padding='same',
                   kernel_initializer='he_normal',
                   kernel_regularizer=l2(1e-4),
                   name=lyrName+'_conv' if lyrName else None)
  x = inputs
  if convFirst:
    x = convLyr(x)
    if batchNorm:
      x = BatchNormalization(name=lyrName+'_bn' if lyrName else None)(x)
    if activation is not None:
      x = Activation(activation,name=lyrName+'_'+activation if lyrName else None)(x)
  else:
    if batchNorm:
      x = BatchNormalization(name=lyrName+'_bn' if lyrName else None)(x)
    if activation is not None:
      x = Activation(activation,name=lyrName+'_'+activation if lyrName else None)(x)
    x = convLyr(x)

  return x


def resBlkV1(inputs,
             numFilters=16,
             numBlocks=7,
             downsampleOnFirst=True,
             names=None):
  x = inputs
  for run in range(0,numBlocks):
    strides = 1
    blkStr = str(run+1)
    if downsampleOnFirst and run == 0:
      strides = 2
    y = resLyr(inputs=x,
               numFilters=numFilters,
               strides=strides,
               lyrName=names+'_Blk'+blkStr+'_Res1' if names else None)
    y = resLyr(inputs=y,
               numFilters=numFilters,
               activation=None,
               lyrName=names+'_Blk'+blkStr+'_Res2' if names else None)
```

```
    if downsampleOnFirst and run == 0:
      x = resLyr(inputs=x,
                 numFilters = numFilters,
                 kernelSz=1,
                 strides=strides,
                 activation=None,
                 batchNorm=False,
                 lyrName=names+'_Blk'+blkStr+'_lin' if names else None)
    x = add([x,y],
            name=names+'_Blk'+blkStr+'_add' if names else None)
    x  = Activation('relu',
                    name=names+'_Blk'+blkStr+'_relu' if names else None)(x)

  return x


def createResNetV1(inputShape=(128,128,3),
                   numClasses=3):
  inputs = Input(shape=inputShape)
  v = resLyr(inputs,
             lyrName='Input')

  #v = Dropout(0.2)(v)

  v = resBlkV1(inputs=v,
               numFilters=16,
               numBlocks=7,
               downsampleOnFirst=False,
               names='Stg1')

  #v = Dropout(0.2)(v)

  v = resBlkV1(inputs=v,
               numFilters=32,
               numBlocks=7,
               downsampleOnFirst=True,
               names='Stg2')

  #v = Dropout(0.2)(v)

  v = resBlkV1(inputs=v,
               numFilters=64,
               numBlocks=7,
               downsampleOnFirst=True,
               names='Stg3')

  #v = Dropout(0.2)(v)

  v = resBlkV1(inputs=v,
               numFilters=128,
               numBlocks=7,
               downsampleOnFirst=True,
               names='Stg4')

  #v = Dropout(0.2)(v)

  v = AveragePooling2D(pool_size=8,
                       name='AvgPool')(v)

  #v = Dropout(0.2)(v)
```

```
  v = Flatten()(v)
  outputs = Dense(numClasses,
                  activation='softmax',
                  kernel_initializer='he_normal')(v)
  model = Model(inputs=inputs,outputs=outputs)
  model.compile(loss='categorical_crossentropy',
                optimizer=optmz,
                metrics=['accuracy'])

  return model


                                # Setup the models
model       = createResNetV1()  # This is meant for training
modelGo     = createResNetV1()  # This is used for final testing

model.summary()
```

```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
Connected to
==================================================================
input_1 (InputLayer)         [(None, 128, 128, 3)      0
_________________________________________________________________
Input_conv (Conv2D)          (None, 128, 128, 16)      448
input_1[0][0]
_________________________________________________________________
Input_bn (BatchNormalization (None, 128, 128, 16)      64
Input_conv[0][0]
_________________________________________________________________
Input_relu (Activation)      (None, 128, 128, 16)      0
Input_bn[0][0]
_________________________________________________________________
Stg1_Blk1_Res1_conv (Conv2D) (None, 128, 128, 16)      2320
Input_relu[0][0]
_________________________________________________________________
Stg1_Blk1_Res1_bn (BatchNorm (None, 128, 128, 16)      64
Stg1_Blk1_Res1_conv[0][0]
_________________________________________________________________
Stg1_Blk1_Res1_relu (Activat (None, 128, 128, 16)      0
Stg1_Blk1_Res1_bn[0][0]
_________________________________________________________________
Stg1_Blk1_Res2_conv (Conv2D) (None, 128, 128, 16)      2320
Stg1_Blk1_Res1_relu[0][0]
_________________________________________________________________
Stg1_Blk1_Res2_bn (BatchNorm (None, 128, 128, 16)      64
Stg1_Blk1_Res2_conv[0][0]
_________________________________________________________________
Stg1_Blk1_add (Add)          (None, 128, 128, 16)      0
Input_relu[0][0]
                                                       Stg1_Blk1
_Res2_bn[0][0]
_________________________________________________________________
Stg1_Blk1_relu (Activation)  (None, 128, 128, 16)      0
Stg1_Blk1_add[0][0]
_________________________________________________________________
Stg1_Blk2_Res1_conv (Conv2D) (None, 128, 128, 16)      2320
Stg1_Blk1_relu[0][0]
_________________________________________________________________
Stg1_Blk2_Res1_bn (BatchNorm (None, 128, 128, 16)      64
Stg1_Blk2_Res1_conv[0][0]
_________________________________________________________________
Stg1_Blk2_Res1_relu (Activat (None, 128, 128, 16)      0
Stg1_Blk2
```

```
_Res1_bn[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk2_Res2_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk2
_Res1_relu[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk2_Res2_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk2
_Res2_conv[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk2_add (Add)             (None, 128, 128, 16) 0           Stg1_Blk1
_relu[0][0]
                                                                 Stg1_Blk2
_Res2_bn[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk2_relu (Activation)     (None, 128, 128, 16) 0           Stg1_Blk2
_add[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk3_Res1_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk2
_relu[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk3_Res1_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk3
_Res1_conv[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk3_Res1_relu (Activation (None, 128, 128, 16) 0           Stg1_Blk3
_Res1_bn[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk3_Res2_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk3
_Res1_relu[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk3_Res2_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk3
_Res2_conv[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk3_add (Add)             (None, 128, 128, 16) 0           Stg1_Blk2
_relu[0][0]
                                                                 Stg1_Blk3
_Res2_bn[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk3_relu (Activation)     (None, 128, 128, 16) 0           Stg1_Blk3
_add[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk4_Res1_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk3
_relu[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk4_Res1_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk4
_Res1_conv[0][0]
__________________________________________________________________________________
_____________________
Stg1_Blk4_Res1_relu (Activation (None, 128, 128, 16) 0           Stg1_Blk4
_Res1_bn[0][0]
```

```
_____
Stg1_Blk4_Res2_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk4
_Res1_relu[0][0]
_____
_____
Stg1_Blk4_Res2_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk4
_Res2_conv[0][0]
_____
_____
Stg1_Blk4_add (Add)             (None, 128, 128, 16) 0           Stg1_Blk3
_relu[0][0]
                                                                 Stg1_Blk4
_Res2_bn[0][0]
_____
_____
Stg1_Blk4_relu (Activation)     (None, 128, 128, 16) 0           Stg1_Blk4
_add[0][0]
_____
_____
Stg1_Blk5_Res1_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk4
_relu[0][0]
_____
_____
Stg1_Blk5_Res1_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk5
_Res1_conv[0][0]
_____
_____
Stg1_Blk5_Res1_relu (Activation (None, 128, 128, 16) 0           Stg1_Blk5
_Res1_bn[0][0]
_____
_____
Stg1_Blk5_Res2_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk5
_Res1_relu[0][0]
_____
_____
Stg1_Blk5_Res2_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk5
_Res2_conv[0][0]
_____
_____
Stg1_Blk5_add (Add)             (None, 128, 128, 16) 0           Stg1_Blk4
_relu[0][0]
                                                                 Stg1_Blk5
_Res2_bn[0][0]
_____
_____
Stg1_Blk5_relu (Activation)     (None, 128, 128, 16) 0           Stg1_Blk5
_add[0][0]
_____
_____
Stg1_Blk6_Res1_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk5
_relu[0][0]
_____
_____
Stg1_Blk6_Res1_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk6
_Res1_conv[0][0]
_____
_____
Stg1_Blk6_Res1_relu (Activation (None, 128, 128, 16) 0           Stg1_Blk6
_Res1_bn[0][0]
_____
```

```
_____________________________
Stg1_Blk6_Res2_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk6
_Res1_relu[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk6_Res2_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk6
_Res2_conv[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk6_add (Add)             (None, 128, 128, 16) 0           Stg1_Blk5
_relu[0][0]
                                                                 Stg1_Blk6
_Res2_bn[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk6_relu (Activation)     (None, 128, 128, 16) 0           Stg1_Blk6
_add[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk7_Res1_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk6
_relu[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk7_Res1_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk7
_Res1_conv[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk7_Res1_relu (Activation (None, 128, 128, 16) 0           Stg1_Blk7
_Res1_bn[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk7_Res2_conv (Conv2D)    (None, 128, 128, 16) 2320        Stg1_Blk7
_Res1_relu[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk7_Res2_bn (BatchNormali (None, 128, 128, 16) 64          Stg1_Blk7
_Res2_conv[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk7_add (Add)             (None, 128, 128, 16) 0           Stg1_Blk6
_relu[0][0]
                                                                 Stg1_Blk7
_Res2_bn[0][0]
__________________________________________________________________________________
_____________________________
Stg1_Blk7_relu (Activation)     (None, 128, 128, 16) 0           Stg1_Blk7
_add[0][0]
__________________________________________________________________________________
_____________________________
Stg2_Blk1_Res1_conv (Conv2D)    (None, 64, 64, 32)   4640        Stg1_Blk7
_relu[0][0]
__________________________________________________________________________________
_____________________________
Stg2_Blk1_Res1_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk1
_Res1_conv[0][0]
__________________________________________________________________________________
_____________________________
Stg2_Blk1_Res1_relu (Activation (None, 64, 64, 32)   0           Stg2_Blk1
_Res1_bn[0][0]
__________________________________________________________________________________
_____________________________
```

```
Stg2_Blk1_Res2_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk1
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk1_lin_conv (Conv2D)     (None, 64, 64, 32)   544         Stg1_Blk7
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk1_Res2_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk1
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk1_add (Add)             (None, 64, 64, 32)   0           Stg2_Blk1
_lin_conv[0][0]
                                                                 Stg2_Blk1
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk1_relu (Activation)     (None, 64, 64, 32)   0           Stg2_Blk1
_add[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk2_Res1_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk1
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk2_Res1_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk2
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk2_Res1_relu (Activation (None, 64, 64, 32)   0           Stg2_Blk2
_Res1_bn[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk2_Res2_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk2
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk2_Res2_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk2
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk2_add (Add)             (None, 64, 64, 32)   0           Stg2_Blk1
_relu[0][0]
                                                                 Stg2_Blk2
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk2_relu (Activation)     (None, 64, 64, 32)   0           Stg2_Blk2
_add[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk3_Res1_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk2
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk3_Res1_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk3
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk3_Res1_relu (Activation (None, 64, 64, 32)   0           Stg2_Blk3
```

```
_Res1_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk3_Res2_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk3
_Res1_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk3_Res2_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk3
_Res2_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk3_add (Add)             (None, 64, 64, 32)   0           Stg2_Blk2
_relu[0][0]
                                                                 Stg2_Blk3
_Res2_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk3_relu (Activation)     (None, 64, 64, 32)   0           Stg2_Blk3
_add[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk4_Res1_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk3
_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk4_Res1_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk4
_Res1_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk4_Res1_relu (Activation (None, 64, 64, 32)   0           Stg2_Blk4
_Res1_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk4_Res2_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk4
_Res1_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk4_Res2_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk4
_Res2_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk4_add (Add)             (None, 64, 64, 32)   0           Stg2_Blk3
_relu[0][0]
                                                                 Stg2_Blk4
_Res2_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk4_relu (Activation)     (None, 64, 64, 32)   0           Stg2_Blk4
_add[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk5_Res1_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk4
_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk5_Res1_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk5
_Res1_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg2_Blk5_Res1_relu (Activation (None, 64, 64, 32)   0           Stg2_Blk5
_Res1_bn[0][0]
```

```
_____
Stg2_Blk5_Res2_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk5
_Res1_relu[0][0]
_____
_____
Stg2_Blk5_Res2_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk5
_Res2_conv[0][0]
_____
_____
Stg2_Blk5_add (Add)             (None, 64, 64, 32)   0           Stg2_Blk4
_relu[0][0]
                                                                 Stg2_Blk5
_Res2_bn[0][0]
_____
_____
Stg2_Blk5_relu (Activation)     (None, 64, 64, 32)   0           Stg2_Blk5
_add[0][0]
_____
_____
Stg2_Blk6_Res1_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk5
_relu[0][0]
_____
_____
Stg2_Blk6_Res1_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk6
_Res1_conv[0][0]
_____
_____
Stg2_Blk6_Res1_relu (Activation (None, 64, 64, 32)   0           Stg2_Blk6
_Res1_bn[0][0]
_____
_____
Stg2_Blk6_Res2_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk6
_Res1_relu[0][0]
_____
_____
Stg2_Blk6_Res2_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk6
_Res2_conv[0][0]
_____
_____
Stg2_Blk6_add (Add)             (None, 64, 64, 32)   0           Stg2_Blk5
_relu[0][0]
                                                                 Stg2_Blk6
_Res2_bn[0][0]
_____
_____
Stg2_Blk6_relu (Activation)     (None, 64, 64, 32)   0           Stg2_Blk6
_add[0][0]
_____
_____
Stg2_Blk7_Res1_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk6
_relu[0][0]
_____
_____
Stg2_Blk7_Res1_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk7
_Res1_conv[0][0]
_____
_____
Stg2_Blk7_Res1_relu (Activation (None, 64, 64, 32)   0           Stg2_Blk7
_Res1_bn[0][0]
_____
```

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_____________________________
Stg2_Blk7_Res2_conv (Conv2D)    (None, 64, 64, 32)   9248        Stg2_Blk7
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk7_Res2_bn (BatchNormali (None, 64, 64, 32)   128         Stg2_Blk7
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk7_add (Add)             (None, 64, 64, 32)   0           Stg2_Blk6
_relu[0][0]
                                                                 Stg2_Blk7
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg2_Blk7_relu (Activation)     (None, 64, 64, 32)   0           Stg2_Blk7
_add[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_Res1_conv (Conv2D)    (None, 32, 32, 64)   18496       Stg2_Blk7
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_Res1_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk1
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_Res1_relu (Activation (None, 32, 32, 64)   0           Stg3_Blk1
_Res1_bn[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_Res2_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk1
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_lin_conv (Conv2D)     (None, 32, 32, 64)   2112        Stg2_Blk7
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_Res2_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk1
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_add (Add)             (None, 32, 32, 64)   0           Stg3_Blk1
_lin_conv[0][0]
                                                                 Stg3_Blk1
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk1_relu (Activation)     (None, 32, 32, 64)   0           Stg3_Blk1
_add[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk2_Res1_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk1
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk2_Res1_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk2
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
```

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Stg3_Blk2_Res1_relu (Activation (None, 32, 32, 64)   0          Stg3_Blk2
_Res1_bn[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk2_Res2_conv (Conv2D)    (None, 32, 32, 64)   36928      Stg3_Blk2
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk2_Res2_bn (BatchNormali (None, 32, 32, 64)   256        Stg3_Blk2
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk2_add (Add)             (None, 32, 32, 64)   0          Stg3_Blk1
_relu[0][0]
                                                                Stg3_Blk2
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk2_relu (Activation)     (None, 32, 32, 64)   0          Stg3_Blk2
_add[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk3_Res1_conv (Conv2D)    (None, 32, 32, 64)   36928      Stg3_Blk2
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk3_Res1_bn (BatchNormali (None, 32, 32, 64)   256        Stg3_Blk3
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk3_Res1_relu (Activation (None, 32, 32, 64)   0          Stg3_Blk3
_Res1_bn[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk3_Res2_conv (Conv2D)    (None, 32, 32, 64)   36928      Stg3_Blk3
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk3_Res2_bn (BatchNormali (None, 32, 32, 64)   256        Stg3_Blk3
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk3_add (Add)             (None, 32, 32, 64)   0          Stg3_Blk2
_relu[0][0]
                                                                Stg3_Blk3
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk3_relu (Activation)     (None, 32, 32, 64)   0          Stg3_Blk3
_add[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk4_Res1_conv (Conv2D)    (None, 32, 32, 64)   36928      Stg3_Blk3
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk4_Res1_bn (BatchNormali (None, 32, 32, 64)   256        Stg3_Blk4
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
Stg3_Blk4_Res1_relu (Activation (None, 32, 32, 64)   0          Stg3_Blk4
```

```
_Res1_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk4_Res2_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk4
_Res1_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk4_Res2_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk4
_Res2_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk4_add (Add)             (None, 32, 32, 64)   0           Stg3_Blk3
_relu[0][0]
                                                                 Stg3_Blk4
_Res2_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk4_relu (Activation)     (None, 32, 32, 64)   0           Stg3_Blk4
_add[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk5_Res1_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk4
_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk5_Res1_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk5
_Res1_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk5_Res1_relu (Activation (None, 32, 32, 64)   0           Stg3_Blk5
_Res1_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk5_Res2_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk5
_Res1_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk5_Res2_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk5
_Res2_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk5_add (Add)             (None, 32, 32, 64)   0           Stg3_Blk4
_relu[0][0]
                                                                 Stg3_Blk5
_Res2_bn[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk5_relu (Activation)     (None, 32, 32, 64)   0           Stg3_Blk5
_add[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk6_Res1_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk5
_relu[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk6_Res1_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk6
_Res1_conv[0][0]
__________________________________________________________________________________________
_____________________________
Stg3_Blk6_Res1_relu (Activation (None, 32, 32, 64)   0           Stg3_Blk6
_Res1_bn[0][0]
```

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__________________________________________________________________________________________________
__________________________
Stg3_Blk6_Res2_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk6
_Res1_relu[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk6_Res2_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk6
_Res2_conv[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk6_add (Add)             (None, 32, 32, 64)   0           Stg3_Blk5
_relu[0][0]
                                                                 Stg3_Blk6
_Res2_bn[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk6_relu (Activation)     (None, 32, 32, 64)   0           Stg3_Blk6
_add[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk7_Res1_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk6
_relu[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk7_Res1_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk7
_Res1_conv[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk7_Res1_relu (Activation (None, 32, 32, 64)   0           Stg3_Blk7
_Res1_bn[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk7_Res2_conv (Conv2D)    (None, 32, 32, 64)   36928       Stg3_Blk7
_Res1_relu[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk7_Res2_bn (BatchNormali (None, 32, 32, 64)   256         Stg3_Blk7
_Res2_conv[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk7_add (Add)             (None, 32, 32, 64)   0           Stg3_Blk6
_relu[0][0]
                                                                 Stg3_Blk7
_Res2_bn[0][0]
__________________________________________________________________________________________________
__________________________
Stg3_Blk7_relu (Activation)     (None, 32, 32, 64)   0           Stg3_Blk7
_add[0][0]
__________________________________________________________________________________________________
__________________________
Stg4_Blk1_Res1_conv (Conv2D)    (None, 16, 16, 128)  73856       Stg3_Blk7
_relu[0][0]
__________________________________________________________________________________________________
__________________________
Stg4_Blk1_Res1_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk1
_Res1_conv[0][0]
__________________________________________________________________________________________________
__________________________
Stg4_Blk1_Res1_relu (Activation (None, 16, 16, 128)  0           Stg4_Blk1
_Res1_bn[0][0]
__________________________________________________________________________________________________
```

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_____________________________
Stg4_Blk1_Res2_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk1
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk1_lin_conv (Conv2D)     (None, 16, 16, 128)  8320        Stg3_Blk7
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk1_Res2_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk1
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk1_add (Add)             (None, 16, 16, 128)  0           Stg4_Blk1
_lin_conv[0][0]
                                                                 Stg4_Blk1
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk1_relu (Activation)     (None, 16, 16, 128)  0           Stg4_Blk1
_add[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk2_Res1_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk1
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk2_Res1_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk2
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk2_Res1_relu (Activation (None, 16, 16, 128)  0           Stg4_Blk2
_Res1_bn[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk2_Res2_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk2
_Res1_relu[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk2_Res2_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk2
_Res2_conv[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk2_add (Add)             (None, 16, 16, 128)  0           Stg4_Blk1
_relu[0][0]
                                                                 Stg4_Blk2
_Res2_bn[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk2_relu (Activation)     (None, 16, 16, 128)  0           Stg4_Blk2
_add[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk3_Res1_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk2
_relu[0][0]
__________________________________________________________________________
_____________________________
Stg4_Blk3_Res1_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk3
_Res1_conv[0][0]
__________________________________________________________________________
_____________________________
```

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Stg4_Blk3_Res1_relu (Activation (None, 16, 16, 128)  0          Stg4_Blk3
_Res1_bn[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk3_Res2_conv (Conv2D)    (None, 16, 16, 128)  147584     Stg4_Blk3
_Res1_relu[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk3_Res2_bn (BatchNormali (None, 16, 16, 128)  512        Stg4_Blk3
_Res2_conv[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk3_add (Add)             (None, 16, 16, 128)  0          Stg4_Blk2
_relu[0][0]
                                                                Stg4_Blk3
_Res2_bn[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk3_relu (Activation)     (None, 16, 16, 128)  0          Stg4_Blk3
_add[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk4_Res1_conv (Conv2D)    (None, 16, 16, 128)  147584     Stg4_Blk3
_relu[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk4_Res1_bn (BatchNormali (None, 16, 16, 128)  512        Stg4_Blk4
_Res1_conv[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk4_Res1_relu (Activation (None, 16, 16, 128)  0          Stg4_Blk4
_Res1_bn[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk4_Res2_conv (Conv2D)    (None, 16, 16, 128)  147584     Stg4_Blk4
_Res1_relu[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk4_Res2_bn (BatchNormali (None, 16, 16, 128)  512        Stg4_Blk4
_Res2_conv[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk4_add (Add)             (None, 16, 16, 128)  0          Stg4_Blk3
_relu[0][0]
                                                                Stg4_Blk4
_Res2_bn[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk4_relu (Activation)     (None, 16, 16, 128)  0          Stg4_Blk4
_add[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk5_Res1_conv (Conv2D)    (None, 16, 16, 128)  147584     Stg4_Blk4
_relu[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk5_Res1_bn (BatchNormali (None, 16, 16, 128)  512        Stg4_Blk5
_Res1_conv[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk5_Res1_relu (Activation (None, 16, 16, 128)  0          Stg4_Blk5
```

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_Res1_bn[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk5_Res2_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk5
_Res1_relu[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk5_Res2_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk5
_Res2_conv[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk5_add (Add)             (None, 16, 16, 128)  0           Stg4_Blk4
_relu[0][0]
                                                                 Stg4_Blk5
_Res2_bn[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk5_relu (Activation)     (None, 16, 16, 128)  0           Stg4_Blk5
_add[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk6_Res1_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk5
_relu[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk6_Res1_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk6
_Res1_conv[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk6_Res1_relu (Activation (None, 16, 16, 128)  0           Stg4_Blk6
_Res1_bn[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk6_Res2_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk6
_Res1_relu[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk6_Res2_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk6
_Res2_conv[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk6_add (Add)             (None, 16, 16, 128)  0           Stg4_Blk5
_relu[0][0]
                                                                 Stg4_Blk6
_Res2_bn[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk6_relu (Activation)     (None, 16, 16, 128)  0           Stg4_Blk6
_add[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk7_Res1_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk6
_relu[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk7_Res1_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk7
_Res1_conv[0][0]
__________________________________________________________________________________
_____________________
Stg4_Blk7_Res1_relu (Activation (None, 16, 16, 128)  0           Stg4_Blk7
_Res1_bn[0][0]
```

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__________________________________________________________________________
_____________________
Stg4_Blk7_Res2_conv (Conv2D)    (None, 16, 16, 128)  147584      Stg4_Blk7
_Res1_relu[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk7_Res2_bn (BatchNormali (None, 16, 16, 128)  512         Stg4_Blk7
_Res2_conv[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk7_add (Add)             (None, 16, 16, 128)  0           Stg4_Blk6
_relu[0][0]
                                                                 Stg4_Blk7
_Res2_bn[0][0]
__________________________________________________________________________
_____________________
Stg4_Blk7_relu (Activation)     (None, 16, 16, 128)  0           Stg4_Blk7
_add[0][0]
__________________________________________________________________________
_____________________
AvgPool (AveragePooling2D)      (None, 2, 2, 128)    0           Stg4_Blk7
_relu[0][0]
__________________________________________________________________________
_____________________
flatten (Flatten)               (None, 512)          0           AvgPool
[0][0]
__________________________________________________________________________
_____________________
dense (Dense)                   (None, 3)            1539        flatten
[0][0]
==========================================================================
========================
Total params: 2,674,819
Trainable params: 2,668,067
Non-trainable params: 6,752
__________________________________________________________________________
_____________________
```

In [0]:

```
def lrSchedule(epoch):
    lr  = 1e-3

    if epoch > 160:
        lr  *= 0.5e-3

    elif epoch > 140:
        lr  *= 1e-3

    elif epoch > 120:
        lr  *= 1e-2

    elif epoch > 80:
        lr  *= 1e-1

    print('Learning rate: ', lr)

    return lr

LRScheduler     = LearningRateScheduler(lrSchedule)

                        # Create checkpoint for the training
                        # This checkpoint performs model saving when
                        # an epoch gives highest testing accuracy
filepath        = '/content/drive/My Drive/Colab/' + modelname + ".hdf5"
checkpoint      = ModelCheckpoint(filepath,
                                  monitor='val_acc',
                                  verbose=0,
                                  save_best_only=True,
                                  mode='max')

                        # Log the epoch detail into csv
csv_logger      = CSVLogger('/content/drive/My Drive/Colab/' + modelname +'.csv')
callbacks_list  = [checkpoint,csv_logger,LRScheduler]
```

In [18]:

```
                            # Fit the model
datagen = ImageDataGenerator(width_shift_range=0.1,
                             height_shift_range=0.1,
                             rotation_range=20,
                             horizontal_flip=True,
                             vertical_flip=False)

model.fit_generator(datagen.flow(trDat, trLbl, batch_size=32),
                    validation_data=(tsDat, tsLbl),
                    epochs=200, #originally 200
                    verbose=1,
                    steps_per_epoch=len(trDat)/32,
                    callbacks=callbacks_list)
```

```
Learning rate:  0.001
Epoch 1/200
65/64 [==============================] - 101s 2s/step - loss: 2.4236 - ac
c: 0.4151 - val_loss: 9.0405 - val_acc: 0.3482
Learning rate:  0.001
Epoch 2/200
65/64 [==============================] - 46s 715ms/step - loss: 1.8928 - a
cc: 0.4427 - val_loss: 1.9190 - val_acc: 0.3395
Learning rate:  0.001
Epoch 3/200
65/64 [==============================] - 47s 719ms/step - loss: 1.7454 - a
cc: 0.5036 - val_loss: 1.9861 - val_acc: 0.3424
Learning rate:  0.001
Epoch 4/200
65/64 [==============================] - 47s 721ms/step - loss: 1.7084 - a
cc: 0.5138 - val_loss: 2.2107 - val_acc: 0.3443
Learning rate:  0.001
Epoch 5/200
65/64 [==============================] - 48s 744ms/step - loss: 1.6956 - a
cc: 0.5046 - val_loss: 1.7500 - val_acc: 0.4130
Learning rate:  0.001
Epoch 6/200
65/64 [==============================] - 49s 749ms/step - loss: 1.6399 - a
cc: 0.5288 - val_loss: 1.7874 - val_acc: 0.4410
Learning rate:  0.001
Epoch 7/200
65/64 [==============================] - 48s 738ms/step - loss: 1.5803 - a
cc: 0.5467 - val_loss: 1.6056 - val_acc: 0.5029
Learning rate:  0.001
Epoch 8/200
65/64 [==============================] - 47s 717ms/step - loss: 1.5674 - a
cc: 0.5510 - val_loss: 1.7704 - val_acc: 0.4342
Learning rate:  0.001
Epoch 9/200
65/64 [==============================] - 47s 716ms/step - loss: 1.5472 - a
cc: 0.5728 - val_loss: 2.2801 - val_acc: 0.3820
Learning rate:  0.001
Epoch 10/200
65/64 [==============================] - 46s 710ms/step - loss: 1.5057 - a
cc: 0.5593 - val_loss: 2.0970 - val_acc: 0.3743
Learning rate:  0.001
Epoch 11/200
65/64 [==============================] - 46s 709ms/step - loss: 1.5053 - a
cc: 0.5646 - val_loss: 2.9430 - val_acc: 0.3578
Learning rate:  0.001
Epoch 12/200
65/64 [==============================] - 47s 717ms/step - loss: 1.4480 - a
cc: 0.5801 - val_loss: 1.6358 - val_acc: 0.4749
Learning rate:  0.001
Epoch 13/200
65/64 [==============================] - 48s 739ms/step - loss: 1.3822 - a
cc: 0.6091 - val_loss: 1.6825 - val_acc: 0.5426
Learning rate:  0.001
Epoch 14/200
65/64 [==============================] - 46s 707ms/step - loss: 1.3920 - a
cc: 0.5864 - val_loss: 2.1088 - val_acc: 0.4516
Learning rate:  0.001
Epoch 15/200
65/64 [==============================] - 46s 707ms/step - loss: 1.3609 - a
cc: 0.5941 - val_loss: 1.8441 - val_acc: 0.5068
Learning rate:  0.001
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Epoch 16/200
65/64 [==============================] - 47s 716ms/step - loss: 1.3154 - a
cc: 0.6270 - val_loss: 2.3031 - val_acc: 0.3965
Learning rate:  0.001
Epoch 17/200
65/64 [==============================] - 46s 705ms/step - loss: 1.3290 - a
cc: 0.6159 - val_loss: 2.6612 - val_acc: 0.4062
Learning rate:  0.001
Epoch 18/200
65/64 [==============================] - 47s 716ms/step - loss: 1.2942 - a
cc: 0.6081 - val_loss: 1.3784 - val_acc: 0.5377
Learning rate:  0.001
Epoch 19/200
65/64 [==============================] - 48s 734ms/step - loss: 1.2495 - a
cc: 0.6222 - val_loss: 1.3743 - val_acc: 0.6248
Learning rate:  0.001
Epoch 20/200
65/64 [==============================] - 46s 706ms/step - loss: 1.2848 - a
cc: 0.6096 - val_loss: 2.0731 - val_acc: 0.3714
Learning rate:  0.001
Epoch 21/200
65/64 [==============================] - 47s 717ms/step - loss: 1.2017 - a
cc: 0.6430 - val_loss: 1.6241 - val_acc: 0.5097
Learning rate:  0.001
Epoch 22/200
65/64 [==============================] - 46s 710ms/step - loss: 1.1683 - a
cc: 0.6551 - val_loss: 1.6631 - val_acc: 0.5290
Learning rate:  0.001
Epoch 23/200
65/64 [==============================] - 48s 738ms/step - loss: 1.1318 - a
cc: 0.6628 - val_loss: 1.2543 - val_acc: 0.6296
Learning rate:  0.001
Epoch 24/200
65/64 [==============================] - 47s 721ms/step - loss: 1.1202 - a
cc: 0.6725 - val_loss: 1.5148 - val_acc: 0.5580
Learning rate:  0.001
Epoch 25/200
65/64 [==============================] - 47s 716ms/step - loss: 1.1364 - a
cc: 0.6623 - val_loss: 1.8947 - val_acc: 0.4072
Learning rate:  0.001
Epoch 26/200
65/64 [==============================] - 46s 714ms/step - loss: 1.0984 - a
cc: 0.6730 - val_loss: 1.5743 - val_acc: 0.4265
Learning rate:  0.001
Epoch 27/200
65/64 [==============================] - 48s 741ms/step - loss: 1.0706 - a
cc: 0.6763 - val_loss: 1.3317 - val_acc: 0.5822
Learning rate:  0.001
Epoch 28/200
65/64 [==============================] - 48s 745ms/step - loss: 1.0735 - a
cc: 0.6846 - val_loss: 2.2628 - val_acc: 0.4188
Learning rate:  0.001
Epoch 29/200
65/64 [==============================] - 47s 728ms/step - loss: 1.0584 - a
cc: 0.6831 - val_loss: 1.7286 - val_acc: 0.5764
Learning rate:  0.001
Epoch 30/200
65/64 [==============================] - 46s 715ms/step - loss: 1.0390 - a
cc: 0.6870 - val_loss: 1.3687 - val_acc: 0.5600
Learning rate:  0.001
Epoch 31/200
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65/64 [==============================] - 46s 712ms/step - loss: 1.0153 - a
cc: 0.6860 - val_loss: 1.5989 - val_acc: 0.5290
Learning rate:  0.001
Epoch 32/200
65/64 [==============================] - 46s 715ms/step - loss: 1.0014 - a
cc: 0.6957 - val_loss: 2.5687 - val_acc: 0.3762
Learning rate:  0.001
Epoch 33/200
65/64 [==============================] - 46s 712ms/step - loss: 1.0038 - a
cc: 0.7025 - val_loss: 1.2518 - val_acc: 0.5629
Learning rate:  0.001
Epoch 34/200
65/64 [==============================] - 46s 710ms/step - loss: 0.9483 - a
cc: 0.7107 - val_loss: 1.7432 - val_acc: 0.5648
Learning rate:  0.001
Epoch 35/200
65/64 [==============================] - 46s 715ms/step - loss: 0.9956 - a
cc: 0.6884 - val_loss: 1.5314 - val_acc: 0.4710
Learning rate:  0.001
Epoch 36/200
65/64 [==============================] - 47s 717ms/step - loss: 0.9542 - a
cc: 0.7073 - val_loss: 4.9015 - val_acc: 0.4845
Learning rate:  0.001
Epoch 37/200
65/64 [==============================] - 46s 715ms/step - loss: 0.9162 - a
cc: 0.7213 - val_loss: 2.8079 - val_acc: 0.3820
Learning rate:  0.001
Epoch 38/200
65/64 [==============================] - 47s 719ms/step - loss: 0.9540 - a
cc: 0.7005 - val_loss: 1.5209 - val_acc: 0.5851
Learning rate:  0.001
Epoch 39/200
65/64 [==============================] - 47s 720ms/step - loss: 0.9210 - a
cc: 0.7141 - val_loss: 1.4638 - val_acc: 0.6044
Learning rate:  0.001
Epoch 40/200
65/64 [==============================] - 46s 711ms/step - loss: 0.9422 - a
cc: 0.7063 - val_loss: 1.1728 - val_acc: 0.6228
Learning rate:  0.001
Epoch 41/200
65/64 [==============================] - 46s 714ms/step - loss: 0.9070 - a
cc: 0.7325 - val_loss: 1.4455 - val_acc: 0.6209
Learning rate:  0.001
Epoch 42/200
65/64 [==============================] - 46s 710ms/step - loss: 0.9390 - a
cc: 0.7054 - val_loss: 1.6507 - val_acc: 0.5222
Learning rate:  0.001
Epoch 43/200
65/64 [==============================] - 47s 716ms/step - loss: 0.8735 - a
cc: 0.7421 - val_loss: 1.7612 - val_acc: 0.5426
Learning rate:  0.001
Epoch 44/200
65/64 [==============================] - 47s 721ms/step - loss: 0.8863 - a
cc: 0.7199 - val_loss: 1.2592 - val_acc: 0.6286
Learning rate:  0.001
Epoch 45/200
65/64 [==============================] - 47s 716ms/step - loss: 0.8559 - a
cc: 0.7441 - val_loss: 17.0085 - val_acc: 0.3820
Learning rate:  0.001
Epoch 46/200
65/64 [==============================] - 46s 710ms/step - loss: 0.8503 - a
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cc: 0.7388 - val_loss: 1.9883 - val_acc: 0.5648
Learning rate:  0.001
Epoch 47/200
65/64 [==============================] - 46s 713ms/step - loss: 0.8387 - a
cc: 0.7344 - val_loss: 1.5985 - val_acc: 0.5338
Learning rate:  0.001
Epoch 48/200
65/64 [==============================] - 47s 721ms/step - loss: 0.8421 - a
cc: 0.7591 - val_loss: 1.7855 - val_acc: 0.5097
Learning rate:  0.001
Epoch 49/200
65/64 [==============================] - 46s 704ms/step - loss: 0.8300 - a
cc: 0.7479 - val_loss: 1.4366 - val_acc: 0.5522
Learning rate:  0.001
Epoch 50/200
65/64 [==============================] - 46s 713ms/step - loss: 0.8276 - a
cc: 0.7591 - val_loss: 2.6999 - val_acc: 0.5203
Learning rate:  0.001
Epoch 51/200
65/64 [==============================] - 47s 719ms/step - loss: 0.8322 - a
cc: 0.7475 - val_loss: 1.5490 - val_acc: 0.5832
Learning rate:  0.001
Epoch 52/200
65/64 [==============================] - 48s 734ms/step - loss: 0.8407 - a
cc: 0.7615 - val_loss: 1.1516 - val_acc: 0.6576
Learning rate:  0.001
Epoch 53/200
65/64 [==============================] - 46s 708ms/step - loss: 0.8224 - a
cc: 0.7552 - val_loss: 2.2156 - val_acc: 0.3830
Learning rate:  0.001
Epoch 54/200
65/64 [==============================] - 46s 713ms/step - loss: 0.7615 - a
cc: 0.7765 - val_loss: 2.0908 - val_acc: 0.3743
Learning rate:  0.001
Epoch 55/200
65/64 [==============================] - 47s 726ms/step - loss: 0.8025 - a
cc: 0.7736 - val_loss: 1.2576 - val_acc: 0.5812
Learning rate:  0.001
Epoch 56/200
65/64 [==============================] - 48s 734ms/step - loss: 0.7753 - a
cc: 0.7726 - val_loss: 1.0805 - val_acc: 0.6567
Learning rate:  0.001
Epoch 57/200
65/64 [==============================] - 48s 735ms/step - loss: 0.8118 - a
cc: 0.7581 - val_loss: 2.1391 - val_acc: 0.4729
Learning rate:  0.001
Epoch 58/200
65/64 [==============================] - 48s 731ms/step - loss: 0.7411 - a
cc: 0.7905 - val_loss: 0.8201 - val_acc: 0.7466
Learning rate:  0.001
Epoch 59/200
65/64 [==============================] - 47s 719ms/step - loss: 0.7583 - a
cc: 0.7775 - val_loss: 3.2092 - val_acc: 0.4207
Learning rate:  0.001
Epoch 60/200
65/64 [==============================] - 46s 712ms/step - loss: 0.7629 - a
cc: 0.7731 - val_loss: 1.0915 - val_acc: 0.6470
Learning rate:  0.001
Epoch 61/200
65/64 [==============================] - 46s 714ms/step - loss: 0.7480 - a
cc: 0.7808 - val_loss: 0.9313 - val_acc: 0.6983
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Learning rate:  0.001
Epoch 62/200
65/64 [==============================] - 47s 716ms/step - loss: 0.7335 - a
cc: 0.7833 - val_loss: 1.8084 - val_acc: 0.6470
Learning rate:  0.001
Epoch 63/200
65/64 [==============================] - 47s 716ms/step - loss: 0.7616 - a
cc: 0.7808 - val_loss: 2.1196 - val_acc: 0.4623
Learning rate:  0.001
Epoch 64/200
65/64 [==============================] - 46s 713ms/step - loss: 0.7423 - a
cc: 0.7915 - val_loss: 2.4329 - val_acc: 0.3781
Learning rate:  0.001
Epoch 65/200
65/64 [==============================] - 46s 708ms/step - loss: 0.7164 - a
cc: 0.7973 - val_loss: 2.0860 - val_acc: 0.5203
Learning rate:  0.001
Epoch 66/200
65/64 [==============================] - 47s 716ms/step - loss: 0.7220 - a
cc: 0.7929 - val_loss: 1.3191 - val_acc: 0.5899
Learning rate:  0.001
Epoch 67/200
65/64 [==============================] - 46s 708ms/step - loss: 0.6970 - a
cc: 0.8016 - val_loss: 1.8376 - val_acc: 0.5435
Learning rate:  0.001
Epoch 68/200
65/64 [==============================] - 46s 711ms/step - loss: 0.7125 - a
cc: 0.7992 - val_loss: 1.6689 - val_acc: 0.4903
Learning rate:  0.001
Epoch 69/200
65/64 [==============================] - 47s 719ms/step - loss: 0.6819 - a
cc: 0.8104 - val_loss: 1.9207 - val_acc: 0.5387
Learning rate:  0.001
Epoch 70/200
65/64 [==============================] - 46s 712ms/step - loss: 0.6736 - a
cc: 0.8133 - val_loss: 1.1165 - val_acc: 0.6267
Learning rate:  0.001
Epoch 71/200
65/64 [==============================] - 46s 713ms/step - loss: 0.6764 - a
cc: 0.8181 - val_loss: 3.4220 - val_acc: 0.4478
Learning rate:  0.001
Epoch 72/200
65/64 [==============================] - 46s 715ms/step - loss: 0.6990 - a
cc: 0.8079 - val_loss: 1.5710 - val_acc: 0.5484
Learning rate:  0.001
Epoch 73/200
65/64 [==============================] - 46s 709ms/step - loss: 0.6722 - a
cc: 0.8045 - val_loss: 3.5402 - val_acc: 0.4497
Learning rate:  0.001
Epoch 74/200
65/64 [==============================] - 47s 718ms/step - loss: 0.6797 - a
cc: 0.8210 - val_loss: 1.8005 - val_acc: 0.5329
Learning rate:  0.001
Epoch 75/200
65/64 [==============================] - 46s 714ms/step - loss: 0.6622 - a
cc: 0.8133 - val_loss: 1.8557 - val_acc: 0.5774
Learning rate:  0.001
Epoch 76/200
65/64 [==============================] - 46s 715ms/step - loss: 0.6669 - a
cc: 0.8147 - val_loss: 2.1980 - val_acc: 0.4323
Learning rate:  0.001
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Epoch 77/200
65/64 [==============================] - 47s 722ms/step - loss: 0.6675 - a
cc: 0.8249 - val_loss: 2.3756 - val_acc: 0.4884
Learning rate:  0.001
Epoch 78/200
65/64 [==============================] - 46s 715ms/step - loss: 0.6640 - a
cc: 0.8278 - val_loss: 2.3370 - val_acc: 0.4681
Learning rate:  0.001
Epoch 79/200
65/64 [==============================] - 46s 713ms/step - loss: 0.6517 - a
cc: 0.8205 - val_loss: 1.4416 - val_acc: 0.5967
Learning rate:  0.001
Epoch 80/200
65/64 [==============================] - 47s 719ms/step - loss: 0.6221 - a
cc: 0.8326 - val_loss: 7.1090 - val_acc: 0.4855
Learning rate:  0.001
Epoch 81/200
65/64 [==============================] - 47s 720ms/step - loss: 0.6505 - a
cc: 0.8297 - val_loss: 1.0813 - val_acc: 0.6489
Learning rate:  0.0001
Epoch 82/200
65/64 [==============================] - 47s 718ms/step - loss: 0.5518 - a
cc: 0.8694 - val_loss: 1.1187 - val_acc: 0.6460
Learning rate:  0.0001
Epoch 83/200
65/64 [==============================] - 47s 720ms/step - loss: 0.5065 - a
cc: 0.8766 - val_loss: 0.9396 - val_acc: 0.7215
Learning rate:  0.0001
Epoch 84/200
65/64 [==============================] - 48s 741ms/step - loss: 0.4983 - a
cc: 0.8829 - val_loss: 1.1386 - val_acc: 0.6518
Learning rate:  0.0001
Epoch 85/200
65/64 [==============================] - 49s 749ms/step - loss: 0.5050 - a
cc: 0.8940 - val_loss: 1.1610 - val_acc: 0.6567
Learning rate:  0.0001
Epoch 86/200
65/64 [==============================] - 47s 728ms/step - loss: 0.4842 - a
cc: 0.8926 - val_loss: 1.1286 - val_acc: 0.6867
Learning rate:  0.0001
Epoch 87/200
65/64 [==============================] - 47s 721ms/step - loss: 0.4715 - a
cc: 0.8965 - val_loss: 1.1054 - val_acc: 0.6838
Learning rate:  0.0001
Epoch 88/200
65/64 [==============================] - 46s 713ms/step - loss: 0.4700 - a
cc: 0.8955 - val_loss: 1.2490 - val_acc: 0.6625
Learning rate:  0.0001
Epoch 89/200
65/64 [==============================] - 47s 715ms/step - loss: 0.4736 - a
cc: 0.8960 - val_loss: 1.2762 - val_acc: 0.6644
Learning rate:  0.0001
Epoch 90/200
65/64 [==============================] - 47s 718ms/step - loss: 0.4498 - a
cc: 0.9057 - val_loss: 1.2969 - val_acc: 0.6567
Learning rate:  0.0001
Epoch 91/200
65/64 [==============================] - 47s 716ms/step - loss: 0.4538 - a
cc: 0.8974 - val_loss: 1.0385 - val_acc: 0.7176
Learning rate:  0.0001
Epoch 92/200
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65/64 [==============================] - 47s 726ms/step - loss: 0.4427 - a
cc: 0.9090 - val_loss: 0.9086 - val_acc: 0.7631
Learning rate:  0.0001
Epoch 93/200
65/64 [==============================] - 46s 710ms/step - loss: 0.4300 - a
cc: 0.9124 - val_loss: 1.3004 - val_acc: 0.6731
Learning rate:  0.0001
Epoch 94/200
65/64 [==============================] - 47s 719ms/step - loss: 0.4278 - a
cc: 0.9115 - val_loss: 1.5577 - val_acc: 0.6373
Learning rate:  0.0001
Epoch 95/200
65/64 [==============================] - 46s 714ms/step - loss: 0.4479 - a
cc: 0.9028 - val_loss: 1.1905 - val_acc: 0.6973
Learning rate:  0.0001
Epoch 96/200
65/64 [==============================] - 46s 707ms/step - loss: 0.4198 - a
cc: 0.9163 - val_loss: 1.2103 - val_acc: 0.6838
Learning rate:  0.0001
Epoch 97/200
65/64 [==============================] - 47s 721ms/step - loss: 0.4084 - a
cc: 0.9202 - val_loss: 1.3644 - val_acc: 0.6702
Learning rate:  0.0001
Epoch 98/200
65/64 [==============================] - 46s 707ms/step - loss: 0.4290 - a
cc: 0.9163 - val_loss: 1.4266 - val_acc: 0.6402
Learning rate:  0.0001
Epoch 99/200
65/64 [==============================] - 46s 713ms/step - loss: 0.4397 - a
cc: 0.9042 - val_loss: 1.2302 - val_acc: 0.6750
Learning rate:  0.0001
Epoch 100/200
65/64 [==============================] - 47s 726ms/step - loss: 0.4333 - a
cc: 0.9129 - val_loss: 1.1600 - val_acc: 0.6944
Learning rate:  0.0001
Epoch 101/200
65/64 [==============================] - 48s 731ms/step - loss: 0.4124 - a
cc: 0.9226 - val_loss: 1.1028 - val_acc: 0.7050
Learning rate:  0.0001
Epoch 102/200
65/64 [==============================] - 47s 720ms/step - loss: 0.3906 - a
cc: 0.9255 - val_loss: 1.1966 - val_acc: 0.6934
Learning rate:  0.0001
Epoch 103/200
65/64 [==============================] - 47s 721ms/step - loss: 0.4147 - a
cc: 0.9158 - val_loss: 1.3615 - val_acc: 0.6915
Learning rate:  0.0001
Epoch 104/200
65/64 [==============================] - 47s 721ms/step - loss: 0.3801 - a
cc: 0.9284 - val_loss: 1.5526 - val_acc: 0.6663
Learning rate:  0.0001
Epoch 105/200
65/64 [==============================] - 46s 713ms/step - loss: 0.3975 - a
cc: 0.9221 - val_loss: 1.7982 - val_acc: 0.6054
Learning rate:  0.0001
Epoch 106/200
65/64 [==============================] - 47s 717ms/step - loss: 0.3961 - a
cc: 0.9216 - val_loss: 1.4083 - val_acc: 0.6480
Learning rate:  0.0001
Epoch 107/200
65/64 [==============================] - 47s 719ms/step - loss: 0.4037 - a
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cc: 0.9207 - val_loss: 1.0986 - val_acc: 0.7273
Learning rate:  0.0001
Epoch 108/200
65/64 [==============================] - 46s 713ms/step - loss: 0.3774 - a
cc: 0.9289 - val_loss: 1.1067 - val_acc: 0.7302
Learning rate:  0.0001
Epoch 109/200
65/64 [==============================] - 47s 717ms/step - loss: 0.3974 - a
cc: 0.9178 - val_loss: 1.2571 - val_acc: 0.6828
Learning rate:  0.0001
Epoch 110/200
65/64 [==============================] - 47s 716ms/step - loss: 0.3717 - a
cc: 0.9332 - val_loss: 1.3193 - val_acc: 0.6779
Learning rate:  0.0001
Epoch 111/200
65/64 [==============================] - 47s 717ms/step - loss: 0.3796 - a
cc: 0.9269 - val_loss: 1.2686 - val_acc: 0.7118
Learning rate:  0.0001
Epoch 112/200
65/64 [==============================] - 48s 744ms/step - loss: 0.3729 - a
cc: 0.9332 - val_loss: 1.1698 - val_acc: 0.7021
Learning rate:  0.0001
Epoch 113/200
65/64 [==============================] - 48s 741ms/step - loss: 0.3868 - a
cc: 0.9202 - val_loss: 1.3444 - val_acc: 0.6770
Learning rate:  0.0001
Epoch 114/200
65/64 [==============================] - 48s 731ms/step - loss: 0.3621 - a
cc: 0.9357 - val_loss: 1.3828 - val_acc: 0.6847
Learning rate:  0.0001
Epoch 115/200
65/64 [==============================] - 47s 721ms/step - loss: 0.3468 - a
cc: 0.9419 - val_loss: 1.0472 - val_acc: 0.7544
Learning rate:  0.0001
Epoch 116/200
65/64 [==============================] - 46s 715ms/step - loss: 0.3590 - a
cc: 0.9376 - val_loss: 1.5257 - val_acc: 0.6470
Learning rate:  0.0001
Epoch 117/200
65/64 [==============================] - 47s 721ms/step - loss: 0.3645 - a
cc: 0.9328 - val_loss: 1.0979 - val_acc: 0.7408
Learning rate:  0.0001
Epoch 118/200
65/64 [==============================] - 47s 716ms/step - loss: 0.3536 - a
cc: 0.9395 - val_loss: 1.9039 - val_acc: 0.6093
Learning rate:  0.0001
Epoch 119/200
65/64 [==============================] - 46s 709ms/step - loss: 0.3468 - a
cc: 0.9419 - val_loss: 1.5177 - val_acc: 0.6451
Learning rate:  0.0001
Epoch 120/200
65/64 [==============================] - 47s 716ms/step - loss: 0.3513 - a
cc: 0.9410 - val_loss: 1.1304 - val_acc: 0.7456
Learning rate:  0.0001
Epoch 121/200
65/64 [==============================] - 46s 714ms/step - loss: 0.3390 - a
cc: 0.9482 - val_loss: 1.6970 - val_acc: 0.6615
Learning rate:  1e-05
Epoch 122/200
65/64 [==============================] - 47s 721ms/step - loss: 0.3320 - a
cc: 0.9478 - val_loss: 1.6412 - val_acc: 0.6644
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Learning rate:  1e-05
Epoch 123/200
65/64 [==============================] - 47s 724ms/step - loss: 0.3182 - a
cc: 0.9540 - val_loss: 1.4607 - val_acc: 0.6925
Learning rate:  1e-05
Epoch 124/200
65/64 [==============================] - 47s 715ms/step - loss: 0.3157 - a
cc: 0.9565 - val_loss: 1.4195 - val_acc: 0.6973
Learning rate:  1e-05
Epoch 125/200
65/64 [==============================] - 46s 714ms/step - loss: 0.3237 - a
cc: 0.9516 - val_loss: 1.5238 - val_acc: 0.6857
Learning rate:  1e-05
Epoch 126/200
65/64 [==============================] - 47s 724ms/step - loss: 0.3242 - a
cc: 0.9468 - val_loss: 1.5186 - val_acc: 0.6867
Learning rate:  1e-05
Epoch 127/200
65/64 [==============================] - 47s 717ms/step - loss: 0.3135 - a
cc: 0.9502 - val_loss: 1.4662 - val_acc: 0.6954
Learning rate:  1e-05
Epoch 128/200
65/64 [==============================] - 47s 723ms/step - loss: 0.3070 - a
cc: 0.9516 - val_loss: 1.4790 - val_acc: 0.6944
Learning rate:  1e-05
Epoch 129/200
65/64 [==============================] - 47s 717ms/step - loss: 0.3313 - a
cc: 0.9482 - val_loss: 1.4841 - val_acc: 0.6886
Learning rate:  1e-05
Epoch 130/200
65/64 [==============================] - 46s 707ms/step - loss: 0.3105 - a
cc: 0.9531 - val_loss: 1.4713 - val_acc: 0.6983
Learning rate:  1e-05
Epoch 131/200
65/64 [==============================] - 46s 713ms/step - loss: 0.3163 - a
cc: 0.9478 - val_loss: 1.4572 - val_acc: 0.6983
Learning rate:  1e-05
Epoch 132/200
65/64 [==============================] - 46s 714ms/step - loss: 0.3050 - a
cc: 0.9560 - val_loss: 1.4348 - val_acc: 0.7002
Learning rate:  1e-05
Epoch 133/200
65/64 [==============================] - 46s 715ms/step - loss: 0.3041 - a
cc: 0.9584 - val_loss: 1.4688 - val_acc: 0.7070
Learning rate:  1e-05
Epoch 134/200
65/64 [==============================] - 47s 716ms/step - loss: 0.2924 - a
cc: 0.9579 - val_loss: 1.4774 - val_acc: 0.7012
Learning rate:  1e-05
Epoch 135/200
65/64 [==============================] - 46s 713ms/step - loss: 0.3040 - a
cc: 0.9555 - val_loss: 1.4374 - val_acc: 0.7021
Learning rate:  1e-05
Epoch 136/200
65/64 [==============================] - 46s 713ms/step - loss: 0.3035 - a
cc: 0.9536 - val_loss: 1.4220 - val_acc: 0.7012
Learning rate:  1e-05
Epoch 137/200
65/64 [==============================] - 47s 719ms/step - loss: 0.2929 - a
cc: 0.9613 - val_loss: 1.4245 - val_acc: 0.7012
Learning rate:  1e-05
```

```
Epoch 138/200
65/64 [==============================] - 47s 718ms/step - loss: 0.2889 - a
cc: 0.9652 - val_loss: 1.4977 - val_acc: 0.7031
Learning rate:  1e-05
Epoch 139/200
65/64 [==============================] - 47s 716ms/step - loss: 0.3033 - a
cc: 0.9560 - val_loss: 1.5133 - val_acc: 0.7002
Learning rate:  1e-05
Epoch 140/200
65/64 [==============================] - 47s 716ms/step - loss: 0.3074 - a
cc: 0.9579 - val_loss: 1.4478 - val_acc: 0.7118
Learning rate:  1e-05
Epoch 141/200
65/64 [==============================] - 49s 747ms/step - loss: 0.2919 - a
cc: 0.9666 - val_loss: 1.3792 - val_acc: 0.7070
Learning rate:  1e-06
Epoch 142/200
65/64 [==============================] - 48s 735ms/step - loss: 0.3173 - a
cc: 0.9502 - val_loss: 1.4085 - val_acc: 0.7108
Learning rate:  1e-06
Epoch 143/200
65/64 [==============================] - 47s 723ms/step - loss: 0.3037 - a
cc: 0.9550 - val_loss: 1.4397 - val_acc: 0.7050
Learning rate:  1e-06
Epoch 144/200
65/64 [==============================] - 47s 720ms/step - loss: 0.3008 - a
cc: 0.9618 - val_loss: 1.4398 - val_acc: 0.7060
Learning rate:  1e-06
Epoch 145/200
65/64 [==============================] - 46s 714ms/step - loss: 0.3192 - a
cc: 0.9458 - val_loss: 1.4388 - val_acc: 0.7050
Learning rate:  1e-06
Epoch 146/200
65/64 [==============================] - 46s 715ms/step - loss: 0.3023 - a
cc: 0.9526 - val_loss: 1.4523 - val_acc: 0.7050
Learning rate:  1e-06
Epoch 147/200
65/64 [==============================] - 47s 717ms/step - loss: 0.2937 - a
cc: 0.9589 - val_loss: 1.4570 - val_acc: 0.7012
Learning rate:  1e-06
Epoch 148/200
65/64 [==============================] - 46s 715ms/step - loss: 0.2923 - a
cc: 0.9647 - val_loss: 1.4665 - val_acc: 0.7012
Learning rate:  1e-06
Epoch 149/200
65/64 [==============================] - 47s 717ms/step - loss: 0.3032 - a
cc: 0.9536 - val_loss: 1.4580 - val_acc: 0.7041
Learning rate:  1e-06
Epoch 150/200
65/64 [==============================] - 46s 715ms/step - loss: 0.2956 - a
cc: 0.9603 - val_loss: 1.4520 - val_acc: 0.7041
Learning rate:  1e-06
Epoch 151/200
65/64 [==============================] - 46s 714ms/step - loss: 0.2929 - a
cc: 0.9642 - val_loss: 1.4451 - val_acc: 0.7041
Learning rate:  1e-06
Epoch 152/200
65/64 [==============================] - 46s 712ms/step - loss: 0.3074 - a
cc: 0.9555 - val_loss: 1.4672 - val_acc: 0.7031
Learning rate:  1e-06
Epoch 153/200
```

```
65/64 [==============================] - 46s 715ms/step - loss: 0.2940 - a
cc: 0.9613 - val_loss: 1.4476 - val_acc: 0.7079
Learning rate:  1e-06
Epoch 154/200
65/64 [==============================] - 47s 721ms/step - loss: 0.2960 - a
cc: 0.9608 - val_loss: 1.4528 - val_acc: 0.7070
Learning rate:  1e-06
Epoch 155/200
65/64 [==============================] - 46s 705ms/step - loss: 0.2887 - a
cc: 0.9598 - val_loss: 1.4573 - val_acc: 0.7060
Learning rate:  1e-06
Epoch 156/200
65/64 [==============================] - 46s 703ms/step - loss: 0.3192 - a
cc: 0.9487 - val_loss: 1.4641 - val_acc: 0.7070
Learning rate:  1e-06
Epoch 157/200
65/64 [==============================] - 47s 719ms/step - loss: 0.3053 - a
cc: 0.9565 - val_loss: 1.4606 - val_acc: 0.7079
Learning rate:  1e-06
Epoch 158/200
65/64 [==============================] - 46s 708ms/step - loss: 0.2972 - a
cc: 0.9608 - val_loss: 1.4533 - val_acc: 0.7070
Learning rate:  1e-06
Epoch 159/200
65/64 [==============================] - 47s 718ms/step - loss: 0.2962 - a
cc: 0.9598 - val_loss: 1.4605 - val_acc: 0.7050
Learning rate:  1e-06
Epoch 160/200
65/64 [==============================] - 47s 720ms/step - loss: 0.3102 - a
cc: 0.9560 - val_loss: 1.4641 - val_acc: 0.7079
Learning rate:  1e-06
Epoch 161/200
65/64 [==============================] - 46s 710ms/step - loss: 0.3008 - a
cc: 0.9623 - val_loss: 1.4723 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 162/200
65/64 [==============================] - 46s 712ms/step - loss: 0.3067 - a
cc: 0.9545 - val_loss: 1.4703 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 163/200
65/64 [==============================] - 47s 719ms/step - loss: 0.2931 - a
cc: 0.9618 - val_loss: 1.4671 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 164/200
65/64 [==============================] - 46s 708ms/step - loss: 0.2944 - a
cc: 0.9657 - val_loss: 1.4735 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 165/200
65/64 [==============================] - 47s 716ms/step - loss: 0.2867 - a
cc: 0.9676 - val_loss: 1.4639 - val_acc: 0.7070
Learning rate:  5e-07
Epoch 166/200
65/64 [==============================] - 47s 716ms/step - loss: 0.2915 - a
cc: 0.9603 - val_loss: 1.4753 - val_acc: 0.7070
Learning rate:  5e-07
Epoch 167/200
65/64 [==============================] - 47s 716ms/step - loss: 0.2850 - a
cc: 0.9676 - val_loss: 1.4703 - val_acc: 0.7041
Learning rate:  5e-07
Epoch 168/200
65/64 [==============================] - 46s 706ms/step - loss: 0.2995 - a
```

```
cc: 0.9584 - val_loss: 1.4729 - val_acc: 0.7031
Learning rate:  5e-07
Epoch 169/200
65/64 [==============================] - 48s 732ms/step - loss: 0.2843 - a
cc: 0.9666 - val_loss: 1.4687 - val_acc: 0.7041
Learning rate:  5e-07
Epoch 170/200
65/64 [==============================] - 48s 745ms/step - loss: 0.3063 - a
cc: 0.9502 - val_loss: 1.4604 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 171/200
65/64 [==============================] - 48s 745ms/step - loss: 0.3004 - a
cc: 0.9555 - val_loss: 1.4805 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 172/200
65/64 [==============================] - 46s 709ms/step - loss: 0.2919 - a
cc: 0.9618 - val_loss: 1.4880 - val_acc: 0.7012
Learning rate:  5e-07
Epoch 173/200
65/64 [==============================] - 47s 717ms/step - loss: 0.2947 - a
cc: 0.9613 - val_loss: 1.4804 - val_acc: 0.7031
Learning rate:  5e-07
Epoch 174/200
65/64 [==============================] - 47s 719ms/step - loss: 0.2966 - a
cc: 0.9618 - val_loss: 1.4790 - val_acc: 0.7031
Learning rate:  5e-07
Epoch 175/200
65/64 [==============================] - 46s 715ms/step - loss: 0.2990 - a
cc: 0.9555 - val_loss: 1.4713 - val_acc: 0.7041
Learning rate:  5e-07
Epoch 176/200
65/64 [==============================] - 47s 717ms/step - loss: 0.2866 - a
cc: 0.9652 - val_loss: 1.4738 - val_acc: 0.7041
Learning rate:  5e-07
Epoch 177/200
65/64 [==============================] - 46s 712ms/step - loss: 0.3012 - a
cc: 0.9594 - val_loss: 1.4625 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 178/200
65/64 [==============================] - 46s 715ms/step - loss: 0.2899 - a
cc: 0.9589 - val_loss: 1.4607 - val_acc: 0.7089
Learning rate:  5e-07
Epoch 179/200
65/64 [==============================] - 46s 714ms/step - loss: 0.2851 - a
cc: 0.9613 - val_loss: 1.4626 - val_acc: 0.7079
Learning rate:  5e-07
Epoch 180/200
65/64 [==============================] - 46s 713ms/step - loss: 0.2833 - a
cc: 0.9695 - val_loss: 1.4471 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 181/200
65/64 [==============================] - 46s 707ms/step - loss: 0.2894 - a
cc: 0.9594 - val_loss: 1.4618 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 182/200
65/64 [==============================] - 47s 715ms/step - loss: 0.2796 - a
cc: 0.9657 - val_loss: 1.4703 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 183/200
65/64 [==============================] - 46s 715ms/step - loss: 0.2875 - a
cc: 0.9690 - val_loss: 1.4741 - val_acc: 0.7060
```

```
Learning rate:  5e-07
Epoch 184/200
65/64 [==============================] - 46s 715ms/step - loss: 0.3064 - a
cc: 0.9502 - val_loss: 1.4800 - val_acc: 0.7041
Learning rate:  5e-07
Epoch 185/200
65/64 [==============================] - 47s 721ms/step - loss: 0.2843 - a
cc: 0.9647 - val_loss: 1.4827 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 186/200
65/64 [==============================] - 47s 720ms/step - loss: 0.3125 - a
cc: 0.9531 - val_loss: 1.4800 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 187/200
65/64 [==============================] - 47s 721ms/step - loss: 0.2874 - a
cc: 0.9637 - val_loss: 1.4731 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 188/200
65/64 [==============================] - 47s 717ms/step - loss: 0.3096 - a
cc: 0.9536 - val_loss: 1.4799 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 189/200
65/64 [==============================] - 46s 711ms/step - loss: 0.2959 - a
cc: 0.9540 - val_loss: 1.4816 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 190/200
65/64 [==============================] - 46s 714ms/step - loss: 0.2953 - a
cc: 0.9584 - val_loss: 1.4796 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 191/200
65/64 [==============================] - 47s 717ms/step - loss: 0.2967 - a
cc: 0.9584 - val_loss: 1.4801 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 192/200
65/64 [==============================] - 46s 708ms/step - loss: 0.2941 - a
cc: 0.9627 - val_loss: 1.4779 - val_acc: 0.7041
Learning rate:  5e-07
Epoch 193/200
65/64 [==============================] - 47s 721ms/step - loss: 0.3013 - a
cc: 0.9560 - val_loss: 1.4782 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 194/200
65/64 [==============================] - 46s 715ms/step - loss: 0.3054 - a
cc: 0.9598 - val_loss: 1.4797 - val_acc: 0.7041
Learning rate:  5e-07
Epoch 195/200
65/64 [==============================] - 47s 720ms/step - loss: 0.2964 - a
cc: 0.9589 - val_loss: 1.4796 - val_acc: 0.7050
Learning rate:  5e-07
Epoch 196/200
65/64 [==============================] - 47s 716ms/step - loss: 0.2851 - a
cc: 0.9618 - val_loss: 1.4834 - val_acc: 0.7070
Learning rate:  5e-07
Epoch 197/200
65/64 [==============================] - 47s 718ms/step - loss: 0.2906 - a
cc: 0.9584 - val_loss: 1.4881 - val_acc: 0.7060
Learning rate:  5e-07
Epoch 198/200
65/64 [==============================] - 48s 733ms/step - loss: 0.3081 - a
cc: 0.9502 - val_loss: 1.4836 - val_acc: 0.7070
Learning rate:  5e-07
```

```
Epoch 199/200
65/64 [==============================] - 48s 744ms/step - loss: 0.2977 - a
cc: 0.9565 - val_loss: 1.4840 - val_acc: 0.7079
Learning rate:  5e-07
Epoch 200/200
65/64 [==============================] - 47s 727ms/step - loss: 0.2933 - a
cc: 0.9642 - val_loss: 1.4870 - val_acc: 0.7079
```

Out[18]:

```
<tensorflow.python.keras.callbacks.History at 0x7fe312cbb390>
```

In [0]:

```
                            # Now the training is complete, we get
                            # another object to load the weights
                            # compile it, so that we can do
                            # final evaluation on it
modelGo.load_weights(filepath)
modelGo.compile(loss='categorical_crossentropy',
                optimizer=optmz,
                metrics=['accuracy'])

                            # Make classification on the test dataset
predicts    = modelGo.predict(tsDat)
```

In [20]:

```
                            # Prepare the classification output
                            # for the classification report
predout     = np.argmax(predicts,axis=1)
testout     = np.argmax(tsLbl,axis=1)
labelname   = ['cat',
               'bird',
               'dog']
                                        # the labels for the classfication report

testScores  = metrics.accuracy_score(testout,predout)
confusion   = metrics.confusion_matrix(testout,predout)

print("Best accuracy (on testing dataset): %.2f%%" % (testScores*100))
print(metrics.classification_report(testout,predout,target_names=labelname,digits=4))
print(confusion)
```

```
Best accuracy (on testing dataset): 76.31%
              precision    recall  f1-score   support

         cat     0.8442    0.7507    0.7947       361
        bird     0.6727    0.9309    0.7810       362
         dog     0.8538    0.5820    0.6922       311

    accuracy                         0.7631      1034
   macro avg     0.7902    0.7545    0.7560      1034
weighted avg     0.7870    0.7631    0.7591      1034

[[271  70  20]
 [ 14 337  11]
 [ 36  94 181]]
```

In [22]:

```
import pandas as pd

records     = pd.read_csv('/content/drive/My Drive/Colab/' + modelname +'.csv')
plt.figure()
plt.subplot(211)
plt.plot(records['val_loss'])
plt.plot(records['loss'])
plt.yticks([0,0.20,0.40,0.60,0.80,1.00])
plt.title('Loss value',fontsize=12)

ax          = plt.gca()
ax.set_xticklabels([])

plt.subplot(212)
plt.plot(records['val_acc'])
plt.plot(records['acc'])
plt.yticks([0.6,0.7,0.8,0.9,1.0])
plt.title('Accuracy',fontsize=12)
plt.show()

#from tensorflow.keras.utils import plot_model

#plot_model(model,
           #to_file=modelname+'_model.pdf',
           #show_shapes=True,
           #show_layer_names=False,
           #rankdir='TB')
```

```
/usr/local/lib/python3.6/dist-packages/matplotlib/font_manager.py:1241: Us
erWarning: findfont: Font family ['Arial'] not found. Falling back to Deja
Vu Sans.
  (prop.get_family(), self.defaultFamily[fontext]))
```