

In [1]:

```
import pandas as pd
import numpy as np
import itertools
import keras
from sklearn import metrics
from sklearn.metrics import confusion_matrix
from keras.preprocessing.image import ImageDataGenerator, img_to_array, load_img
from keras.models import Sequential
from keras import optimizers
from keras.preprocessing import image
from keras.layers import Dropout, Flatten, Dense
from keras import applications
from keras.utils.np_utils import to_categorical
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
%matplotlib inline
import math
import datetime
import time
import os
```

In [2]:

```
img_width, img_height = 224, 224

top_model_weights_path = 'birds_fc_model.h5'
from google.colab import drive
drive.mount('/content/drive')
base_dir = '/content/drive/MyDrive/birds/'
train_data_dir = os.path.join(base_dir, 'train')
validation_data_dir = os.path.join(base_dir, 'validation')
test_data_dir = os.path.join(base_dir, 'test')

epoch = 10
batch_size = 1
```

Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).

In [3]:

```
vgg16 = applications.VGG16(include_top=False, weights='imagenet')
datagen = ImageDataGenerator(rescale=1. / 255)
```

In [4]:

```
start = datetime.datetime.now()

generator = datagen.flow_from_directory(
    train_data_dir,
    target_size=(img_width, img_height),
    batch_size=batch_size,
    class_mode=None,
    shuffle=False)

nb_train_samples = len(generator filenames)
num_classes = len(generator.class_indices)

predict_size_train = int(math.ceil(nb_train_samples / batch_size))

bottleneck_features_train = vgg16.predict_generator(generator, predict_size_train)

np.save('birds_features_train.npy', bottleneck_features_train)
end= datetime.datetime.now()
elapsed= end-start
print ('Time: ', elapsed)
```

Found 219 images belonging to 10 classes.

```
/usr/local/lib/python3.6/dist-packages/tensorflow/python/keras/engine/training.py:1905: UserWarning: `Model.predict_generator` is deprecated and will be removed in a future version. Please use `Model.predict`, which supports generators.
```

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

Time: 0:00:04.383053

In [5]:

```
start = datetime.datetime.now()

generator = datagen.flow_from_directory(
    test_data_dir,
    target_size=(img_width, img_height),
    batch_size=batch_size,
    class_mode=None,
    shuffle=False)

nb_test_samples = len(generator.filesnames)
num_classes = len(generator.class_indices)

predict_size_test = int(math.ceil(nb_test_samples / batch_size))

bottleneck_features_test = vgg16.predict_generator(generator, predict_size_train)

np.save('birds_features_test.npy', bottleneck_features_test)
end= datetime.datetime.now()
elapsed= end-start
print ('Time: ', elapsed)
```

Found 29 images belonging to 10 classes.

```
/usr/local/lib/python3.6/dist-packages/tensorflow/python/keras/engine/training.py:1905: UserWarning: `Model.predict_generator` is deprecated and will be removed in a future version. Please use `Model.predict`, which supports generators.
```

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

WARNING:tensorflow:Your input ran out of data; interrupting training. Make sure that your dataset or generator can generate at least `steps_per_epoch * epochs` batches (in this case, 219 batches). You may need to use the repeat() function when building your dataset.

Time: 0:00:00.381778

In [6]:

```
start = datetime.datetime.now()

generator = datagen.flow_from_directory(
    validation_data_dir,
    target_size=(img_width, img_height),
    batch_size=batch_size,
    class_mode=None,
    shuffle=False)

nb_validation_samples = len(generator.filesnames)
num_classes = len(generator.class_indices)

predict_size_validation = int(math.ceil(nb_validation_samples / batch_size))

bottleneck_features_validation = vgg16.predict_generator(generator, predict_size_validation)

np.save('birds_features_validation.npy', bottleneck_features_validation)
end= datetime.datetime.now()
elapsed= end-start
print ('Time: ', elapsed)
```

Found 69 images belonging to 10 classes.

```
/usr/local/lib/python3.6/dist-packages/tensorflow/python/keras/engine/training.py:1905: UserWarning: `Model.predict_generator` is deprecated and will be removed in a future version. Please use `Model.predict`, which supports generators.
```

```
warnings.warn('`Model.predict_generator` is deprecated and '
```

Time: 0:00:00.733668

In [7]:

```
generator_top = datagen.flow_from_directory(
    train_data_dir,
    target_size=(img_width, img_height),
    batch_size=batch_size,
    class_mode='categorical',
    shuffle=False)

nb_train_samples = len(generator_top.filenames)
num_classes = len(generator_top.class_indices)

train_data = np.load('birds_features_train.npy')

train_labels = generator_top.classes

train_labels = to_categorical(train_labels, num_classes=num_classes)
```

Found 219 images belonging to 10 classes.

In [8]:

```
generator_top = datagen.flow_from_directory(
    test_data_dir,
    target_size=(img_width, img_height),
    batch_size=batch_size,
    class_mode='categorical',
    shuffle=False)

nb_test_samples = len(generator_top.filenames)
num_classes = len(generator_top.class_indices)

test_data = np.load('birds_features_test.npy')

test_labels = generator_top.classes

test_labels = to_categorical(test_labels, num_classes=num_classes)
```

Found 29 images belonging to 10 classes.

In [9]:

```
generator_top = datagen.flow_from_directory(
    validation_data_dir,
    target_size=(img_width, img_height),
    batch_size=batch_size,
    class_mode='categorical',
    shuffle=False)

nb_validation_samples = len(generator_top.filenames)
num_classes = len(generator_top.class_indices)

validation_data = np.load('birds_features_validation.npy')

validation_labels = generator_top.classes

validation_labels = to_categorical(validation_labels, num_classes=num_classes)
```

Found 69 images belonging to 10 classes.