Soyabean Leaf Disease Classification

1. Business Problem

1.1 Problem Description

Plants play a crucial role in people's daily life in the form of vegetables, fruits and various consumer goods. So, identifying plant leaf diseases is very important for farmers in enhancing agricultural productivity. But, due to wide variety of diseases, leaf disease identification by human eye is time-consuming, difficult and also less accurate. Therefore, there is a need for **Automatic Leaf Disease Identification** techniques which helps farmers to identify various diseases with less efforts, less time and more accurate. These techniques also helps in healthy monitoring of fields that ensures quality agricultural products.

1.2 Problem Statement

Given a leaf, identify the disease that leaf has, among various diseases with high accuracy using image processing techniques.

1.3 Real world/Business Objectives and Constraints

Objectives:

1. Predict the disease for a leaf that is not yet identified.
2. We want to find probabilities of leaf having various diseases so that we can choose high probability as predicted disease (Softmax).
3. Minimize the difference between predicted and actual disease (Categorical Cross Entropy).

Constraints:

1. No strict latency concerns.

1.4 References

1. https://www.appliedaicourse.com/ (https://www.appliedaicourse.com/)
2. https://www.digipathos-rep.cnptia.embrapa.br/jspui/ (https://www.digipathos-rep.cnptia.embrapa.br/jspui/)
3. https://elitedatascience.com/imbalanced-classes (https://elitedatascience.com/imbalanced-classes)
4. https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_ml/py_kmeans/py_kmeans_opencv/py_kmeans_opencv.html (https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_ml/py_kmeans/py_kmeans_opencv/py_kmeans_opencv.html)
5. https://towardsdatascience.com/introduction-to-image-segmentation-with-k-means-clustering-83fd0a9e2fc3 (https://towardsdatascience.com/introduction-to-image-segmentation-with-k-means-clustering-83fd0a9e2fc3)

2. Deep Learning Problem

2.1 Data Collection

- The dataset contains leaf images of soyabean plant. Data is collected from Digipathos Repository.
  Data source: https://www.digipathos-rep.cnptia.embrapa.br/jspui/ (https://www.digipathos-rep.cnptia.embrapa.br/jspui/)
- Only single leaf images are used in this case study.
- This dataset has 10 different types of leaf diseases. They are

  1. Bacterial Blight
  2. Brown Spot
  3. Copper Phytotoxicity
  4. Downy Mildew
  5. Healthy
  6. Mosaic Virus
  7. Powdery Mildew
  8. Rust
  9. Rust and Target Spot
  10. Southern Blight

2.2 Mapping the real world problem to DL Problem

2.2.1 Type of Deep Learning Problem

It is multi-class classification problem, for a given leaf we need to predict the disease among various diseases that leaf would have.

2.2.2 Performance Metrics

- Accuracy - It is the ratio of no. of true predictions to the total no. of predictions.
- Confusion Matrix - Matrix(table) that helps in visualizing the performance of model.

2.2.3 Train and Test Construction

We randomly split train and test data in the ratio 85:15. Since, dataset is very small we need more data for training.

3. Exploratory Data Analysis

```
In [0]:  # Importing necessary packages
         import os
         import cv2
         import numpy as np
         import pandas as pd

         %matplotlib inline
         import matplotlib.pyplot as plt
         import seaborn as sns
         from tqdm import tqdm
```

In [2]:
```python
from google.colab import drive
drive.mount('/content/drive')
```

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

3.1 Reading data

In [0]:
```python
# Basic info of dataset
dataset = '/content/drive/My Drive/Leaf Disease Classification/Soyabean-Original/'
folders = os.listdir(dataset)
folders.sort()

print("Total no. of leaf diseases :", len(folders))
print("Names of leaf diseases are as follows :")
print(folders)
```

Total no. of leaf diseases : 10
Names of leaf diseases are as follows :
['Bacterial Blight', 'Brown Spot', 'Copper Phytotoxicity', 'Downy Mildew', 'Healthy', 'Mosaic Virus', 'Powdery Milde
w', 'Rust', 'Rust and Target Spot', 'Southern Blight']

In [0]:
```python
# Count no.of images w.r.t each disease
img_count = {}
for folder in folders:
    cnt = len(os.listdir(dataset+folder+os.sep))
    img_count[folder] = cnt

img_count
```

Out[0]:
```
{'Bacterial Blight': 51,
 'Brown Spot': 13,
 'Copper Phytotoxicity': 23,
 'Downy Mildew': 33,
 'Healthy': 9,
 'Mosaic Virus': 22,
 'Powdery Mildew': 74,
 'Rust': 64,
 'Rust and Target Spot': 32,
 'Southern Blight': 62}
```

In [0]:
```python
print("Total no. of leaf images in the dataset : ", sum(img_count.values()))
```
```
Total no. of leaf images in the dataset :  383
```

In [0]:
```python
# Example datapoint: Displaying a leaf image from 'Bacterial Blight' class
ex_path = dataset+'Bacterial Blight/DSC_0038.jpg'
img_ex = cv2.imread(ex_path)
img_rgb = cv2.cvtColor(img_ex, cv2.COLOR_BGR2RGB)

plt.imshow(img_rgb)
```

Out[0]: <matplotlib.image.AxesImage at 0x7f230c7cd400>
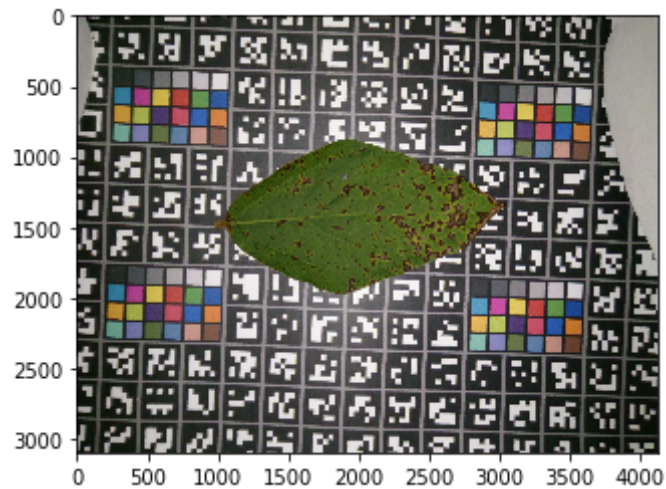
3.2 Distribution of data points among output classes

```
In [0]: # Plotting barplots of no.of leaf images w.r.t each disease
        plt.bar(img_count.keys(), img_count.values())
        plt.xticks(rotation='vertical')
        plt.show()
```
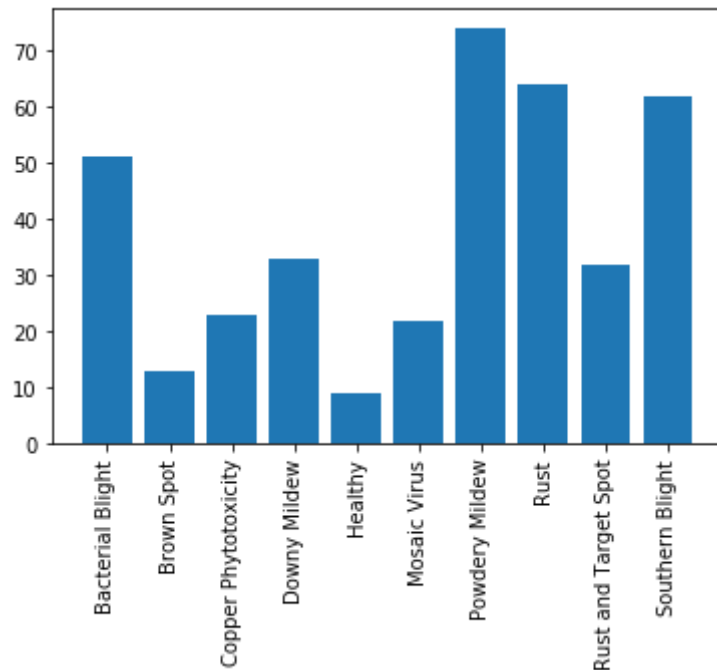

- Total no. of leaf images in dataset is very few (383). There is a need for data-augmentation.
- Dataset is highly imbalanced. We need to perform upsampling techniques.

3.3 Data Preparation

- There are some images in different classes with same image name. So, we rename all the images to avoid duplicate naming.

```
In [0]:  idx = 1    #start index for naming images ex: IMG_0001.jpg

         for folder in folders:
             imgs = os.listdir(dataset+folder+os.sep)
             imgs.sort()

             for img in imgs:
                 src_name = dataset+folder+os.sep+img
                 dst_name = dataset+folder+os.sep+'IMG_'+format(idx, '04d')+'.jpg'
                 os.rename(src_name, dst_name)
                 idx = idx+1
```

4. Deep Learning Models

- Original leaf images have more background pixels than the actual leaf pixels with non-uniform background.
- Since, only actual leaf pixels are important, we can crop images or perform some image segmentation techniques.
- So, we will experiment with 3 different classification models :
  1. Classification Model on Original Leaf Images
  2. Classification Model on Cropped Leaf Images
  3. Classification Model on Segmented Leaf Images

In [0]:
```python
# Example: Displaying Original, Cropped and Segmented leaf image

path = '/content/drive/My Drive/Leaf Disease Classification/'
img_orig = cv2.imread(path+'Soyabean-Original/Bacterial Blight/IMG_0001.jpg')
img_crop = cv2.imread(path+'Soyabean-Cropped/Bacterial Blight/IMG_CROP_0001.jpg')
img_segt = cv2.imread(path+'Soyabean-Segmented/Bacterial Blight/IMG_SEG_0001.jpg')

img_orig = cv2.cvtColor(img_orig, cv2.COLOR_BGR2RGB)
img_crop = cv2.cvtColor(img_crop, cv2.COLOR_BGR2RGB)
img_segt = cv2.cvtColor(img_segt, cv2.COLOR_BGR2RGB)

img_orig = cv2.resize(img_orig, (244,244), interpolation=cv2.INTER_AREA)
img_crop = cv2.resize(img_crop, (244,244), interpolation=cv2.INTER_AREA)
img_segt = cv2.resize(img_segt, (244,244), interpolation=cv2.INTER_AREA)

f, axs = plt.subplots(1,3, figsize=(10, 3))
axs[0].imshow(img_orig)
axs[1].imshow(img_crop)
axs[2].imshow(img_segt)
```

Out[0]: <matplotlib.image.AxesImage at 0x7f230c005c18>
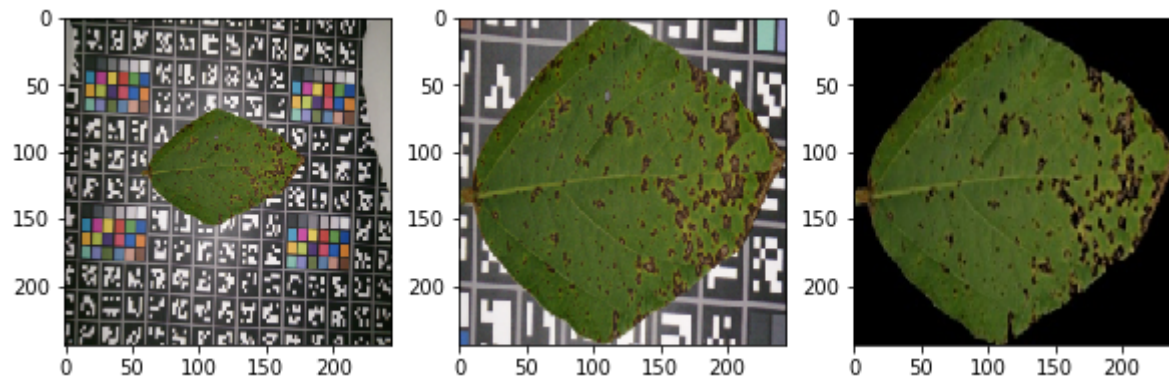
In [3]:
```python
# Importing necessary keras and sklearn libraries
import keras
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers.normalization import BatchNormalization
from keras.layers import Conv2D, MaxPooling2D, MaxPooling2D
from keras.preprocessing.image import ImageDataGenerator
from keras.callbacks import ModelCheckpoint, ReduceLROnPlateau, TensorBoard
import tensorflow

import warnings
warnings.filterwarnings('ignore')

from keras import regularizers
from keras.optimizers import *
from keras.callbacks import EarlyStopping, LearningRateScheduler

import itertools
from sklearn.utils import resample
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, confusion_matrix
```

Using TensorFlow backend.

The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade (https://www.tensorflow.org/guide/migrate) now or ensure your notebook will continue to use TensorFlow 1.x via the
%tensorflow_version 1.x magic: more info (https://colab.research.google.com/notebooks/tensorflow_version.ipynb).

```
In [0]:  # Credits: AppliedAICourse
         def plot_confusion_matrix(test_y, predict_y, labels):

             '''
             This function plots confusion matrix, precision matrix and recall matrix
             using heatmap visualization.

             Parameters:
             test_y: actual output classes
             predict_y: predicted output classes by model
             labels: names of output classes
             '''
             C = confusion_matrix(test_y, predict_y)
             print("Number of misclassified points ", (len(test_y)-np.trace(C))/len(test_y)*100)
             A =(((C.T)/(C.sum(axis=1))).T)
             B =(C/C.sum(axis=0))

             cmap=sns.light_palette("green")
             # representing A in heatmap format
             print("-"*50, "Confusion matrix", "-"*50)
             plt.figure(figsize=(10,5))
             sns.heatmap(C, annot=True, cmap=cmap, fmt=".3f", xticklabels=labels, yticklabels=labels)
             plt.xlabel('Predicted Class')
             plt.ylabel('Original Class')
             plt.show()

             print("-"*50, "Precision matrix", "-"*50)
             plt.figure(figsize=(10,5))
             sns.heatmap(B, annot=True, cmap=cmap, fmt=".3f", xticklabels=labels, yticklabels=labels)
             plt.xlabel('Predicted Class')
             plt.ylabel('Original Class')
             plt.show()
             print("Sum of columns in precision matrix",B.sum(axis=0))

             # representing B in heatmap format
             print("-"*50, "Recall matrix" , "-"*50)
             plt.figure(figsize=(10,5))
             sns.heatmap(A, annot=True, cmap=cmap, fmt=".3f", xticklabels=labels, yticklabels=labels)
             plt.xlabel('Predicted Class')
             plt.ylabel('Original Class')
```

```
        plt.show()
        print("Sum of rows in precision matrix",A.sum(axis=1))
```

4.1 Classification Model on Soyabean Original Images

4.1.1 Preparing Data

```
In [0]: path = '/content/drive/My Drive/Leaf Disease Classification/'
        dataset = '/content/drive/My Drive/Leaf Disease Classification/Soyabean-Original/'
        folders = os.listdir(dataset)
        folders.sort()
```

```
In [0]: # Storing image data in csv file
        img_names = []
        img_array = []
        labels = []

        for folder in folders:
            imgs = os.listdir(dataset+folder+os.sep)
            imgs.sort()

            for img in imgs:
                im = cv2.imread(dataset+folder+os.sep+img)
                im_rgb = cv2.cvtColor(im, cv2.COLOR_BGR2RGB)
                im_size = cv2.resize(im_rgb, (144, 144), interpolation=cv2.INTER_AREA)

                img_names.append(img)
                img_array.append(im_size)
                labels.append(folder)

        df = pd.DataFrame({'Image ID': img_names, 'Class': labels})
        df.to_csv(path+'Files-Original/soyabean_original.csv', index=False)

        # Saving image data in numpy array format
        X = np.asarray(img_array)
        np.save(path+'Files-Original/imgs_original', X)
```

In [0]:
```
data = pd.read_csv(path+'Files-Original/soyabean_original.csv')
data.head()
```

Out[0]:

	Image ID	Class
0	IMG_0001.jpg	Bacterial Blight
1	IMG_0002.jpg	Bacterial Blight
2	IMG_0003.jpg	Bacterial Blight
3	IMG_0004.jpg	Bacterial Blight
4	IMG_0005.jpg	Bacterial Blight

In [0]:
```
data['Class'].value_counts()
```

Out[0]:
```
Powdery Mildew          74
Rust                    64
Southern Blight         62
Bacterial Blight        51
Downy Mildew            33
Rust and Target Spot    32
Copper Phytotoxicity    23
Mosaic Virus            22
Brown Spot              13
Healthy                  9
Name: Class, dtype: int64
```

In [0]:
```python
# Mapping original class labels to integer values
folders = os.listdir(dataset)
folders.sort()

labels = {}
val_cnt = 0
for folder in folders:
    labels[folder] = val_cnt
    val_cnt = val_cnt+1

labels
```

Out[0]: {'Bacterial Blight': 0,
 'Brown Spot': 1,
 'Copper Phytotoxicity': 2,
 'Downy Mildew': 3,
 'Healthy': 4,
 'Mosaic Virus': 5,
 'Powdery Mildew': 6,
 'Rust': 7,
 'Rust and Target Spot': 8,
 'Southern Blight': 9}

In [0]:
```python
X = np.load(path+'Files-Original/imgs_original.npy')
y = data['Class'].map(labels).values

data['Image Array'] = X.tolist()
data['Labels'] = y

data.head()
```

Out[0]:

	Image ID	Class	Image Array	Labels
0	IMG_0001.jpg	Bacterial Blight	[[[133, 132, 125], [132, 130, 124], [49, 54, 4...	0
1	IMG_0002.jpg	Bacterial Blight	[[[25, 31, 28], [11, 16, 8], [14, 17, 11], [26...	0
2	IMG_0003.jpg	Bacterial Blight	[[[119, 119, 113], [18, 26, 20], [49, 54, 41],...	0
3	IMG_0004.jpg	Bacterial Blight	[[[135, 134, 126], [131, 132, 122], [54, 57, 4...	0
4	IMG_0005.jpg	Bacterial Blight	[[[137, 138, 130], [135, 137, 129], [78, 82, 7...	0

In [0]:
```python
# Splitting data into train and test
X = data.drop(['Image ID', 'Class', 'Labels'], axis=1)
y = data['Labels']

X_tr, X_te, y_tr, y_te = train_test_split(X, y, test_size=0.15, stratify=y, random_state=0)
```

```
In [0]: imbalance_train = X_tr.copy()
        imbalance_train['Labels'] = y_tr
        imbalance_train['Labels'].value_counts()
```

```
Out[0]: 6    63
        7    54
        9    53
        0    43
        3    28
        8    27
        5    19
        2    19
        1    11
        4     8
        Name: Labels, dtype: int64
```

In [0]:
```python
# Reference: upsampling in python-https://elitedatascience.com/imbalanced-classes

# Separate majority and minority classes
majority_class = imbalance_train[imbalance_train.Labels == 6]

# Upsampling for imbalance dataset in python
upsampled_classes = [majority_class]
minority_labels = [0,1,2,3,4,5,7,8,9]

for i in minority_labels:
    minority_class = imbalance_train[imbalance_train.Labels == i]
    minority_upsampled = resample(minority_class,
                                  replace = True,
                                  n_samples = majority_class.shape[0],
                                  random_state = 0)
    upsampled_classes.append(minority_upsampled)

train_upsampled = pd.concat(upsampled_classes)
print(train_upsampled['Labels'].value_counts())
```

```
9    63
8    63
7    63
6    63
5    63
4    63
3    63
2    63
1    63
0    63
Name: Labels, dtype: int64
```

In [0]: `train_upsampled.head()`

Out[0]:

	Image Array	Labels
215	[[[16, 21, 10], [110, 101, 83], [136, 132, 121...	6
174	[[[9, 16, 5], [17, 20, 11], [94, 89, 73], [35,...	6
200	[[[20, 24, 14], [21, 24, 15], [39, 43, 30], [4...	6
203	[[[19, 22, 12], [14, 18, 11], [42, 44, 29], [2...	6
162	[[[9, 16, 5], [88, 83, 69], [161, 160, 153], [...	6

In [0]:
```
# Shuffling datapoints in a dataframe
train_shuffled = train_upsampled.sample(frac=1, random_state=0)

X_tr1 = train_shuffled['Image Array'].values
y_tr1 = train_shuffled['Labels'].values
```

In [0]: `train_shuffled.head()`

Out[0]:

	Image Array	Labels
145	[[[146, 143, 127], [146, 144, 129], [90, 93, 8...	5
141	[[[123, 124, 108], [120, 120, 106], [27, 34, 2...	5
91	[[[56, 66, 55], [44, 49, 38], [50, 57, 46], [5...	3
84	[[[32, 33, 35], [38, 37, 40], [41, 41, 45], [4...	2
233	[[[33, 40, 36], [7, 10, 4], [8, 10, 5], [19, 2...	7

4.1.2 CNN Models

```
In [0]:  # Converting class labels into vectorized format
         y_train = keras.utils.to_categorical(y_tr1, num_classes=10)
         y_test = keras.utils.to_categorical(y_te, num_classes=10)
```

```
In [0]:  train_X = X_tr1.tolist()
         X_train = np.asarray(train_X)

         X_te1 = X_te['Image Array'].values
         test_X = X_te1.tolist()
         X_test = np.asarray(test_X)
```

```
In [0]:  # Saving final train and test data
         np.save(path+'Files-Original/X_train_orig', X_train)
         np.save(path+'Files-Original/X_test_orig', X_test)

         np.save(path+'Files-Original/y_train_orig', y_train)
         np.save(path+'Files-Original/y_test_orig', y_test)
```

```
In [0]:  path = '/content/drive/My Drive/Leaf Disease Classification/'
         X_train = np.load(path+'Files-Original/X_train_orig.npy')
         X_test = np.load(path+'Files-Original/X_test_orig.npy')
```

```
In [0]:  y_train = np.load(path+'Files-Original/y_train_orig.npy')
         y_test = np.load(path+'Files-Original/y_test_orig.npy')
```

```
In [7]:  print(X_train.shape, X_test.shape)

         (630, 144, 144, 3) (58, 144, 144, 3)
```

```
In [0]:  # Scaling pixel values - Normalization
         X_train = X_train.astype('float32')
         X_test = X_test.astype('float32')

         X_train = X_train/255
         X_test = X_test/255
```

```
In [0]: # Model parameters
        input_shape = (144, 144, 3)
        num_classes = 10
```

```
In [0]: # Performing Data Augmentation on training data
        datagen = ImageDataGenerator(horizontal_flip=True,
                                     vertical_flip=True)
        datagen.fit(X_train)
        it_train = datagen.flow(X_train, y_train, batch_size=4)
        steps = int(X_train.shape[0]/4)
```

Model 1

```
In [0]: # Saving model weights and other important parameters
        checkpoint = ModelCheckpoint(path+"Results/model_complex.h5", monitor="val_acc",
                                     mode="max", save_best_only=True, verbose=1)
        tensorboard = TensorBoard(log_dir=path+'Results/graph_complex', histogram_freq=4, batch_size=4,
                                  update_freq='epoch')

        callbacks = [checkpoint, tensorboard]
```

```
In [11]: model1 = Sequential()
         model1.add(Conv2D(32, (3, 3), activation='relu', padding='same', strides=(2, 2),
                           kernel_initializer='he_normal', input_shape=input_shape))
         model1.add(Conv2D(64, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
         model1.add(MaxPooling2D(pool_size=(2, 2)))
         model1.add(BatchNormalization())
         model1.add(Dropout(0.2))

         model1.add(Conv2D(128, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
         model1.add(Conv2D(128, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
         model1.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
         model1.add(MaxPooling2D(pool_size=(2, 2)))
         model1.add(BatchNormalization())
         model1.add(Dropout(0.3))

         model1.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
         model1.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
         model1.add(MaxPooling2D(pool_size=(2, 2)))
         model1.add(BatchNormalization())
         model1.add(Dropout(0.3))
         model1.add(Flatten())

         model1.add(Dense(512, activation='relu', kernel_initializer='he_normal'))
         model1.add(Dropout(0.5))
         model1.add(Dense(128, activation='relu', kernel_initializer='he_normal'))
         model1.add(Dropout(0.5))
         model1.add(Dense(64, activation='relu', kernel_initializer='he_normal'))

         model1.add(Dense(num_classes, activation='softmax'))

         model1.compile(loss='categorical_crossentropy', optimizer='rmsprop', metrics=['accuracy'])
         model1.summary()
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:66: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:541: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4479: The name tf.truncated_normal is deprecated. Please use tf.random.truncated_normal instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4267: The name tf.nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:190: The name tf.get_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:197: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:203: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:207: The name tf.global_variables is deprecated. Please use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:216: The name tf.is_variable_initialized is deprecated. Please use tf.compat.v1.is_variable_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:223: The name tf.variables_initializer is deprecated. Please use tf.compat.v1.variables_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:2041: The name tf.nn.fused_batch_norm is deprecated. Please use tf.compat.v1.nn.fused_batch_norm instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:148: The name tf.placeholder_with_default is deprecated. Please use tf.compat.v1.placeholder_with_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3733: calling dropout (from tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4432: The name tf.

random_uniform is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793: The name tf.train.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3576: The name tf.log is deprecated. Please use tf.math.log instead.

Model: "sequential_1"

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 72, 72, 32)	896
conv2d_2 (Conv2D)	(None, 72, 72, 64)	18496
max_pooling2d_1 (MaxPooling2	(None, 36, 36, 64)	0
batch_normalization_1 (Batch	(None, 36, 36, 64)	256
dropout_1 (Dropout)	(None, 36, 36, 64)	0
conv2d_3 (Conv2D)	(None, 36, 36, 128)	73856
conv2d_4 (Conv2D)	(None, 36, 36, 128)	147584
conv2d_5 (Conv2D)	(None, 36, 36, 256)	295168
max_pooling2d_2 (MaxPooling2	(None, 18, 18, 256)	0
batch_normalization_2 (Batch	(None, 18, 18, 256)	1024
dropout_2 (Dropout)	(None, 18, 18, 256)	0
conv2d_6 (Conv2D)	(None, 18, 18, 256)	590080
conv2d_7 (Conv2D)	(None, 18, 18, 256)	590080
max_pooling2d_3 (MaxPooling2	(None, 9, 9, 256)	0
batch_normalization_3 (Batch	(None, 9, 9, 256)	1024

		case_study1
dropout_3 (Dropout)	(None, 9, 9, 256)	0
flatten_1 (Flatten)	(None, 20736)	0
dense_1 (Dense)	(None, 512)	10617344
dropout_4 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 128)	65664
dropout_5 (Dropout)	(None, 128)	0
dense_3 (Dense)	(None, 64)	8256
dense_4 (Dense)	(None, 10)	650

```
=================================================================
Total params: 12,410,378
Trainable params: 12,409,226
Non-trainable params: 1,152
_____
```

```
In [0]: history = model1.fit_generator(it_train, steps_per_epoch=steps,
                                        epochs=300, validation_data=(X_test, y_test),
                                        verbose=1, callbacks=callbacks)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (f
rom tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.
assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.
assign is deprecated. Please use tf.compat.v1.assign instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1068: The name tf.summary.histogram
is deprecated. Please use tf.compat.v1.summary.histogram instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122: The name tf.summary.merge_all
is deprecated. Please use tf.compat.v1.summary.merge_all instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125: The name tf.summary.FileWrite
r is deprecated. Please use tf.compat.v1.summary.FileWriter instead.

Epoch 1/300
157/157 [==============================] - 5s 32ms/step - loss: 12.7361 - acc: 0.1115 - val_loss: 11.7820 - val_acc:
0.2069

Epoch 00001: val_acc improved from -inf to 0.20690, saving model to /content/drive/My Drive/Leaf Disease Classificati
on/Results/model_complex.h5
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265: The name tf.Summary is deprec
ated. Please use tf.compat.v1.Summary instead.

Epoch 2/300
157/157 [==============================] - 3s 16ms/step - loss: 13.6507 - acc: 0.1019 - val_loss: 15.3211 - val_acc:
0.0345

Epoch 00002: val_acc did not improve from 0.20690
Epoch 3/300
157/157 [==============================] - 3s 16ms/step - loss: 13.3130 - acc: 0.1417 - val_loss: 11.0055 - val_acc:
0.2586

Epoch 00003: val_acc improved from 0.20690 to 0.25862, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 4/300
157/157 [==============================] - 3s 16ms/step - loss: 12.6874 - acc: 0.1608 - val_loss: 13.8949 - val_acc:
```

```
0.1379

Epoch 00004: val_acc did not improve from 0.25862
Epoch 5/300
157/157 [==============================] - 3s 17ms/step - loss: 11.6826 - acc: 0.1863 - val_loss: 4.3014 - val_acc:
0.1552

Epoch 00005: val_acc did not improve from 0.25862
Epoch 6/300
157/157 [==============================] - 3s 16ms/step - loss: 7.0521 - acc: 0.1783 - val_loss: 4.3791 - val_acc: 0.
2414

Epoch 00006: val_acc did not improve from 0.25862
Epoch 7/300
157/157 [==============================] - 3s 17ms/step - loss: 5.3041 - acc: 0.1497 - val_loss: 2.3484 - val_acc: 0.
2241

Epoch 00007: val_acc did not improve from 0.25862
Epoch 8/300
157/157 [==============================] - 3s 17ms/step - loss: 4.2369 - acc: 0.1529 - val_loss: 2.5188 - val_acc: 0.
1207

Epoch 00008: val_acc did not improve from 0.25862
Epoch 9/300
157/157 [==============================] - 3s 16ms/step - loss: 2.8209 - acc: 0.1783 - val_loss: 2.2915 - val_acc: 0.
1207

Epoch 00009: val_acc did not improve from 0.25862
Epoch 10/300
157/157 [==============================] - 3s 17ms/step - loss: 2.4941 - acc: 0.1831 - val_loss: 15.0065 - val_acc:
0.0690

Epoch 00010: val_acc did not improve from 0.25862
Epoch 11/300
157/157 [==============================] - 3s 17ms/step - loss: 2.5047 - acc: 0.2197 - val_loss: 2.5737 - val_acc: 0.
2931

Epoch 00011: val_acc improved from 0.25862 to 0.29310, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 12/300
157/157 [==============================] - 3s 17ms/step - loss: 2.3432 - acc: 0.1943 - val_loss: 2.0979 - val_acc: 0.
2414
```

```
       Epoch 00012: val_acc did not improve from 0.29310
       Epoch 13/300
       157/157 [==============================] - 3s 17ms/step - loss: 2.1886 - acc: 0.2277 - val_loss: 2.0187 - val_acc: 0.
       1552


       Epoch 00013: val_acc did not improve from 0.29310
       Epoch 14/300
       157/157 [==============================] - 3s 16ms/step - loss: 2.1614 - acc: 0.2309 - val_loss: 7.1295 - val_acc: 0.
       3276


       Epoch 00014: val_acc improved from 0.29310 to 0.32759, saving model to /content/drive/My Drive/Leaf Disease Classific
       ation/Results/model_complex.h5
       Epoch 15/300
       157/157 [==============================] - 3s 17ms/step - loss: 2.1139 - acc: 0.2595 - val_loss: 7.1163 - val_acc: 0.
       2414


       Epoch 00015: val_acc did not improve from 0.32759
       Epoch 16/300
       157/157 [==============================] - 3s 16ms/step - loss: 2.0133 - acc: 0.2946 - val_loss: 2.3711 - val_acc: 0.
       3103


       Epoch 00016: val_acc did not improve from 0.32759
       Epoch 17/300
       157/157 [==============================] - 3s 18ms/step - loss: 1.9929 - acc: 0.2834 - val_loss: 1.6143 - val_acc: 0.
       3621


       Epoch 00017: val_acc improved from 0.32759 to 0.36207, saving model to /content/drive/My Drive/Leaf Disease Classific
       ation/Results/model_complex.h5
       Epoch 18/300
       157/157 [==============================] - 3s 16ms/step - loss: 1.9943 - acc: 0.3328 - val_loss: 2.0102 - val_acc: 0.
       4138


       Epoch 00018: val_acc improved from 0.36207 to 0.41379, saving model to /content/drive/My Drive/Leaf Disease Classific
       ation/Results/model_complex.h5
       Epoch 19/300
       157/157 [==============================] - 3s 17ms/step - loss: 1.8932 - acc: 0.3439 - val_loss: 2.1560 - val_acc: 0.
       2414


       Epoch 00019: val_acc did not improve from 0.41379
       Epoch 20/300
       157/157 [==============================] - 3s 16ms/step - loss: 1.9245 - acc: 0.2962 - val_loss: 2.0342 - val_acc: 0.
```

```
2931


Epoch 00020: val_acc did not improve from 0.41379
Epoch 21/300
157/157 [==============================] - 3s 17ms/step - loss: 1.8700 - acc: 0.3439 - val_loss: 1.6749 - val_acc: 0.
4138


Epoch 00021: val_acc did not improve from 0.41379
Epoch 22/300
157/157 [==============================] - 3s 16ms/step - loss: 1.8151 - acc: 0.3774 - val_loss: 1.6858 - val_acc: 0.
3448


Epoch 00022: val_acc did not improve from 0.41379
Epoch 23/300
157/157 [==============================] - 3s 16ms/step - loss: 1.7812 - acc: 0.3742 - val_loss: 1.8972 - val_acc: 0.
3966


Epoch 00023: val_acc did not improve from 0.41379
Epoch 24/300
157/157 [==============================] - 3s 17ms/step - loss: 1.7218 - acc: 0.3965 - val_loss: 3.4801 - val_acc: 0.
2069


Epoch 00024: val_acc did not improve from 0.41379
Epoch 25/300
157/157 [==============================] - 3s 17ms/step - loss: 1.6895 - acc: 0.4076 - val_loss: 2.0004 - val_acc: 0.
4310


Epoch 00025: val_acc improved from 0.41379 to 0.43103, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 26/300
157/157 [==============================] - 3s 16ms/step - loss: 1.7887 - acc: 0.3838 - val_loss: 2.4117 - val_acc: 0.
3621


Epoch 00026: val_acc did not improve from 0.43103
Epoch 27/300
157/157 [==============================] - 3s 17ms/step - loss: 1.6462 - acc: 0.4108 - val_loss: 1.9798 - val_acc: 0.
3966


Epoch 00027: val_acc did not improve from 0.43103
Epoch 28/300
157/157 [==============================] - 3s 16ms/step - loss: 1.6827 - acc: 0.4204 - val_loss: 3.8986 - val_acc: 0.
2586
```

```
Epoch 00028: val_acc did not improve from 0.43103
Epoch 29/300
157/157 [==============================] - 3s 16ms/step - loss: 1.6381 - acc: 0.4459 - val_loss: 2.5382 - val_acc: 0.
3448

Epoch 00029: val_acc did not improve from 0.43103
Epoch 30/300
157/157 [==============================] - 3s 16ms/step - loss: 1.6280 - acc: 0.4459 - val_loss: 1.7244 - val_acc: 0.
3276

Epoch 00030: val_acc did not improve from 0.43103
Epoch 31/300
157/157 [==============================] - 3s 16ms/step - loss: 1.5610 - acc: 0.4713 - val_loss: 4.5679 - val_acc: 0.
2414

Epoch 00031: val_acc did not improve from 0.43103
Epoch 32/300
157/157 [==============================] - 3s 17ms/step - loss: 1.5718 - acc: 0.4570 - val_loss: 1.4301 - val_acc: 0.
4310

Epoch 00032: val_acc did not improve from 0.43103
Epoch 33/300
157/157 [==============================] - 3s 17ms/step - loss: 1.4969 - acc: 0.5064 - val_loss: 3.2819 - val_acc: 0.
3793

Epoch 00033: val_acc did not improve from 0.43103
Epoch 34/300
157/157 [==============================] - 3s 16ms/step - loss: 1.4774 - acc: 0.5143 - val_loss: 3.7630 - val_acc: 0.
3621

Epoch 00034: val_acc did not improve from 0.43103
Epoch 35/300
157/157 [==============================] - 3s 17ms/step - loss: 1.4385 - acc: 0.5127 - val_loss: 2.2760 - val_acc: 0.
3793

Epoch 00035: val_acc did not improve from 0.43103
Epoch 36/300
157/157 [==============================] - 3s 16ms/step - loss: 1.3653 - acc: 0.5318 - val_loss: 1.5720 - val_acc: 0.
5172

Epoch 00036: val_acc improved from 0.43103 to 0.51724, saving model to /content/drive/My Drive/Leaf Disease Classific
```

```
ation/Results/model_complex.h5
Epoch 37/300
157/157 [==============================] - 3s 17ms/step - loss: 1.3623 - acc: 0.5303 - val_loss: 13.2160 - val_acc:
0.0690

Epoch 00037: val_acc did not improve from 0.51724
Epoch 38/300
157/157 [==============================] - 3s 16ms/step - loss: 1.4542 - acc: 0.5159 - val_loss: 6.2047 - val_acc: 0.
1207

Epoch 00038: val_acc did not improve from 0.51724
Epoch 39/300
157/157 [==============================] - 3s 17ms/step - loss: 1.3573 - acc: 0.5510 - val_loss: 3.2935 - val_acc: 0.
5345

Epoch 00039: val_acc improved from 0.51724 to 0.53448, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 40/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2359 - acc: 0.5653 - val_loss: 4.9373 - val_acc: 0.
4138

Epoch 00040: val_acc did not improve from 0.53448
Epoch 41/300
157/157 [==============================] - 3s 17ms/step - loss: 1.4265 - acc: 0.5525 - val_loss: 2.8500 - val_acc: 0.
3966

Epoch 00041: val_acc did not improve from 0.53448
Epoch 42/300
157/157 [==============================] - 3s 17ms/step - loss: 1.3638 - acc: 0.5780 - val_loss: 1.2301 - val_acc: 0.
4655

Epoch 00042: val_acc did not improve from 0.53448
Epoch 43/300
157/157 [==============================] - 3s 16ms/step - loss: 1.3211 - acc: 0.5653 - val_loss: 1.2581 - val_acc: 0.
5517

Epoch 00043: val_acc improved from 0.53448 to 0.55172, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 44/300
157/157 [==============================] - 3s 17ms/step - loss: 1.2415 - acc: 0.5923 - val_loss: 1.1751 - val_acc: 0.
5000
```

```
Epoch 00044: val_acc did not improve from 0.55172
Epoch 45/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2165 - acc: 0.6146 - val_loss: 5.7391 - val_acc: 0.
2759

Epoch 00045: val_acc did not improve from 0.55172
Epoch 46/300
157/157 [==============================] - 2s 16ms/step - loss: 1.3033 - acc: 0.5685 - val_loss: 1.5707 - val_acc: 0.
4138

Epoch 00046: val_acc did not improve from 0.55172
Epoch 47/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2613 - acc: 0.6035 - val_loss: 3.0986 - val_acc: 0.
3621

Epoch 00047: val_acc did not improve from 0.55172
Epoch 48/300
157/157 [==============================] - 3s 16ms/step - loss: 1.3151 - acc: 0.5796 - val_loss: 1.3313 - val_acc: 0.
5517

Epoch 00048: val_acc did not improve from 0.55172
Epoch 49/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2182 - acc: 0.6162 - val_loss: 1.7293 - val_acc: 0.
6034

Epoch 00049: val_acc improved from 0.55172 to 0.60345, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 50/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2040 - acc: 0.6226 - val_loss: 2.4452 - val_acc: 0.
4828

Epoch 00050: val_acc did not improve from 0.60345
Epoch 51/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2569 - acc: 0.6130 - val_loss: 4.3365 - val_acc: 0.
3103

Epoch 00051: val_acc did not improve from 0.60345
Epoch 52/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1849 - acc: 0.6226 - val_loss: 1.6489 - val_acc: 0.
4138

Epoch 00052: val_acc did not improve from 0.60345
```

```
Epoch 53/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2464 - acc: 0.6083 - val_loss: 1.5052 - val_acc: 0.
7414

Epoch 00053: val_acc improved from 0.60345 to 0.74138, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 54/300
157/157 [==============================] - 3s 17ms/step - loss: 1.1716 - acc: 0.6545 - val_loss: 13.3825 - val_acc:
0.0862

Epoch 00054: val_acc did not improve from 0.74138
Epoch 55/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1846 - acc: 0.6433 - val_loss: 2.2200 - val_acc: 0.
4828

Epoch 00055: val_acc did not improve from 0.74138
Epoch 56/300
157/157 [==============================] - 3s 16ms/step - loss: 1.2052 - acc: 0.6306 - val_loss: 1.6225 - val_acc: 0.
6379

Epoch 00056: val_acc did not improve from 0.74138
Epoch 57/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1349 - acc: 0.6274 - val_loss: 3.0609 - val_acc: 0.
4483

Epoch 00057: val_acc did not improve from 0.74138
Epoch 58/300
157/157 [==============================] - 3s 17ms/step - loss: 1.2104 - acc: 0.6226 - val_loss: 3.2530 - val_acc: 0.
5172

Epoch 00058: val_acc did not improve from 0.74138
Epoch 59/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0657 - acc: 0.6640 - val_loss: 1.1911 - val_acc: 0.
6724

Epoch 00059: val_acc did not improve from 0.74138
Epoch 60/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0724 - acc: 0.6465 - val_loss: 1.1239 - val_acc: 0.
7069

Epoch 00060: val_acc did not improve from 0.74138
Epoch 61/300
```

```
157/157 [==============================] - 3s 16ms/step - loss: 1.2429 - acc: 0.6290 - val_loss: 4.3974 - val_acc: 0.
3621

Epoch 00061: val_acc did not improve from 0.74138
Epoch 62/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1119 - acc: 0.6672 - val_loss: 1.8578 - val_acc: 0.
4655

Epoch 00062: val_acc did not improve from 0.74138
Epoch 63/300
157/157 [==============================] - 3s 17ms/step - loss: 1.0972 - acc: 0.6879 - val_loss: 7.2875 - val_acc: 0.
2414

Epoch 00063: val_acc did not improve from 0.74138
Epoch 64/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1704 - acc: 0.6529 - val_loss: 3.5464 - val_acc: 0.
3793

Epoch 00064: val_acc did not improve from 0.74138
Epoch 65/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1832 - acc: 0.6656 - val_loss: 2.5637 - val_acc: 0.
4828

Epoch 00065: val_acc did not improve from 0.74138
Epoch 66/300
157/157 [==============================] - 3s 17ms/step - loss: 1.1666 - acc: 0.6688 - val_loss: 7.4192 - val_acc: 0.
2414

Epoch 00066: val_acc did not improve from 0.74138
Epoch 67/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1647 - acc: 0.6561 - val_loss: 3.1283 - val_acc: 0.
4483

Epoch 00067: val_acc did not improve from 0.74138
Epoch 68/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1258 - acc: 0.6767 - val_loss: 1.1856 - val_acc: 0.
5517

Epoch 00068: val_acc did not improve from 0.74138
Epoch 69/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0890 - acc: 0.6751 - val_loss: 1.4401 - val_acc: 0.
4828
```

```
Epoch 00069: val_acc did not improve from 0.74138
Epoch 70/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1685 - acc: 0.6624 - val_loss: 7.3057 - val_acc: 0.
2586

Epoch 00070: val_acc did not improve from 0.74138
Epoch 71/300
157/157 [==============================] - 3s 17ms/step - loss: 1.1095 - acc: 0.6815 - val_loss: 2.5069 - val_acc: 0.
4828

Epoch 00071: val_acc did not improve from 0.74138
Epoch 72/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1042 - acc: 0.6736 - val_loss: 6.4516 - val_acc: 0.
4138

Epoch 00072: val_acc did not improve from 0.74138
Epoch 73/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1961 - acc: 0.6704 - val_loss: 2.7568 - val_acc: 0.
5000

Epoch 00073: val_acc did not improve from 0.74138
Epoch 74/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0948 - acc: 0.6561 - val_loss: 4.1644 - val_acc: 0.
4655

Epoch 00074: val_acc did not improve from 0.74138
Epoch 75/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1315 - acc: 0.6831 - val_loss: 2.5166 - val_acc: 0.
5000

Epoch 00075: val_acc did not improve from 0.74138
Epoch 76/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0420 - acc: 0.6975 - val_loss: 7.2432 - val_acc: 0.
3276

Epoch 00076: val_acc did not improve from 0.74138
Epoch 77/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1025 - acc: 0.7150 - val_loss: 1.2811 - val_acc: 0.
6379

Epoch 00077: val_acc did not improve from 0.74138
```

```
Epoch 78/300
157/157 [==============================] - 3s 17ms/step - loss: 1.1931 - acc: 0.6815 - val_loss: 1.1122 - val_acc: 0.
6207

Epoch 00078: val_acc did not improve from 0.74138
Epoch 79/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0082 - acc: 0.6959 - val_loss: 6.5845 - val_acc: 0.
2931

Epoch 00079: val_acc did not improve from 0.74138
Epoch 80/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9698 - acc: 0.7245 - val_loss: 1.3098 - val_acc: 0.
6724

Epoch 00080: val_acc did not improve from 0.74138
Epoch 81/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9464 - acc: 0.7054 - val_loss: 1.8605 - val_acc: 0.
5517

Epoch 00081: val_acc did not improve from 0.74138
Epoch 82/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0093 - acc: 0.6943 - val_loss: 1.3995 - val_acc: 0.
6207

Epoch 00082: val_acc did not improve from 0.74138
Epoch 83/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9571 - acc: 0.7102 - val_loss: 1.5069 - val_acc: 0.
6379

Epoch 00083: val_acc did not improve from 0.74138
Epoch 84/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0314 - acc: 0.6752 - val_loss: 5.6903 - val_acc: 0.
4138

Epoch 00084: val_acc did not improve from 0.74138
Epoch 85/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8849 - acc: 0.7182 - val_loss: 1.9607 - val_acc: 0.
6379

Epoch 00085: val_acc did not improve from 0.74138
Epoch 86/300
157/157 [==============================] - 3s 17ms/step - loss: 1.0586 - acc: 0.7118 - val_loss: 1.9705 - val_acc: 0.
```

6379

Epoch 00086: val_acc did not improve from 0.74138
Epoch 87/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8839 - acc: 0.7086 - val_loss: 4.4030 - val_acc: 0.3793

Epoch 00087: val_acc did not improve from 0.74138
Epoch 88/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8851 - acc: 0.7532 - val_loss: 3.4592 - val_acc: 0.4828

Epoch 00088: val_acc did not improve from 0.74138
Epoch 89/300
157/157 [==============================] - 3s 17ms/step - loss: 1.0768 - acc: 0.6927 - val_loss: 5.5926 - val_acc: 0.3793

Epoch 00089: val_acc did not improve from 0.74138
Epoch 90/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9519 - acc: 0.7022 - val_loss: 2.8683 - val_acc: 0.5000

Epoch 00090: val_acc did not improve from 0.74138
Epoch 91/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9764 - acc: 0.7245 - val_loss: 3.2638 - val_acc: 0.5690

Epoch 00091: val_acc did not improve from 0.74138
Epoch 92/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9785 - acc: 0.7373 - val_loss: 2.4839 - val_acc: 0.5690

Epoch 00092: val_acc did not improve from 0.74138
Epoch 93/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9793 - acc: 0.7150 - val_loss: 2.9863 - val_acc: 0.4828

Epoch 00093: val_acc did not improve from 0.74138
Epoch 94/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0142 - acc: 0.7516 - val_loss: 3.9564 - val_acc: 0.4828

```
Epoch 00094: val_acc did not improve from 0.74138
Epoch 95/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9198 - acc: 0.7388 - val_loss: 3.3320 - val_acc: 0.
5172


Epoch 00095: val_acc did not improve from 0.74138
Epoch 96/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8597 - acc: 0.7627 - val_loss: 1.7454 - val_acc: 0.
6207


Epoch 00096: val_acc did not improve from 0.74138
Epoch 97/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9387 - acc: 0.7500 - val_loss: 12.1333 - val_acc:
0.1207


Epoch 00097: val_acc did not improve from 0.74138
Epoch 98/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9349 - acc: 0.7420 - val_loss: 5.9895 - val_acc: 0.
4310


Epoch 00098: val_acc did not improve from 0.74138
Epoch 99/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9039 - acc: 0.7691 - val_loss: 1.0920 - val_acc: 0.
6897


Epoch 00099: val_acc did not improve from 0.74138
Epoch 100/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8418 - acc: 0.7707 - val_loss: 9.3252 - val_acc: 0.
2759


Epoch 00100: val_acc did not improve from 0.74138
Epoch 101/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9501 - acc: 0.7659 - val_loss: 8.1996 - val_acc: 0.
3276


Epoch 00101: val_acc did not improve from 0.74138
Epoch 102/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9459 - acc: 0.7245 - val_loss: 5.5714 - val_acc: 0.
4483


Epoch 00102: val_acc did not improve from 0.74138
Epoch 103/300
```

```
157/157 [==============================] - 3s 16ms/step - loss: 0.9799 - acc: 0.7436 - val_loss: 2.7670 - val_acc: 0.
5862

Epoch 00103: val_acc did not improve from 0.74138
Epoch 104/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0336 - acc: 0.7596 - val_loss: 1.9387 - val_acc: 0.
6724

Epoch 00104: val_acc did not improve from 0.74138
Epoch 105/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8828 - acc: 0.7293 - val_loss: 1.9715 - val_acc: 0.
6034

Epoch 00105: val_acc did not improve from 0.74138
Epoch 106/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9557 - acc: 0.7612 - val_loss: 11.4746 - val_acc:
0.1724

Epoch 00106: val_acc did not improve from 0.74138
Epoch 107/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8328 - acc: 0.7882 - val_loss: 1.0763 - val_acc: 0.
7241

Epoch 00107: val_acc did not improve from 0.74138
Epoch 108/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9863 - acc: 0.7596 - val_loss: 3.4304 - val_acc: 0.
5862

Epoch 00108: val_acc did not improve from 0.74138
Epoch 109/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9433 - acc: 0.7596 - val_loss: 1.9941 - val_acc: 0.
7414

Epoch 00109: val_acc did not improve from 0.74138
Epoch 110/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9344 - acc: 0.7596 - val_loss: 10.2441 - val_acc:
0.2759

Epoch 00110: val_acc did not improve from 0.74138
Epoch 111/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7912 - acc: 0.7850 - val_loss: 2.6376 - val_acc: 0.
5345
```

```
Epoch 00111: val_acc did not improve from 0.74138
Epoch 112/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9673 - acc: 0.7468 - val_loss: 1.1806 - val_acc: 0.
6724

Epoch 00112: val_acc did not improve from 0.74138
Epoch 113/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8541 - acc: 0.7548 - val_loss: 3.3973 - val_acc: 0.
5345

Epoch 00113: val_acc did not improve from 0.74138
Epoch 114/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0092 - acc: 0.7357 - val_loss: 14.0710 - val_acc:
0.0862

Epoch 00114: val_acc did not improve from 0.74138
Epoch 115/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8544 - acc: 0.7739 - val_loss: 1.4341 - val_acc: 0.
6724

Epoch 00115: val_acc did not improve from 0.74138
Epoch 116/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8469 - acc: 0.7962 - val_loss: 2.4276 - val_acc: 0.
5862

Epoch 00116: val_acc did not improve from 0.74138
Epoch 117/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9443 - acc: 0.7834 - val_loss: 1.7203 - val_acc: 0.
6379

Epoch 00117: val_acc did not improve from 0.74138
Epoch 118/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9132 - acc: 0.7739 - val_loss: 3.2764 - val_acc: 0.
5000

Epoch 00118: val_acc did not improve from 0.74138
Epoch 119/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9761 - acc: 0.7739 - val_loss: 2.5407 - val_acc: 0.
6552

Epoch 00119: val_acc did not improve from 0.74138
```

```
Epoch 120/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7314 - acc: 0.7882 - val_loss: 1.2651 - val_acc: 0.
7414

Epoch 00120: val_acc did not improve from 0.74138
Epoch 121/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8503 - acc: 0.7978 - val_loss: 4.7602 - val_acc: 0.
5172

Epoch 00121: val_acc did not improve from 0.74138
Epoch 122/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8712 - acc: 0.7755 - val_loss: 1.7851 - val_acc: 0.
7241

Epoch 00122: val_acc did not improve from 0.74138
Epoch 123/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9524 - acc: 0.7739 - val_loss: 3.6439 - val_acc: 0.
5172

Epoch 00123: val_acc did not improve from 0.74138
Epoch 124/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9432 - acc: 0.7834 - val_loss: 4.6788 - val_acc: 0.
3793

Epoch 00124: val_acc did not improve from 0.74138
Epoch 125/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8735 - acc: 0.7994 - val_loss: 0.9300 - val_acc: 0.
6724

Epoch 00125: val_acc did not improve from 0.74138
Epoch 126/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8365 - acc: 0.7882 - val_loss: 1.9817 - val_acc: 0.
6724

Epoch 00126: val_acc did not improve from 0.74138
Epoch 127/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0239 - acc: 0.7420 - val_loss: 10.7810 - val_acc:
0.1897

Epoch 00127: val_acc did not improve from 0.74138
Epoch 128/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7447 - acc: 0.7962 - val_loss: 2.6966 - val_acc: 0.
```

6724

Epoch 00128: val_acc did not improve from 0.74138
Epoch 129/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9731 - acc: 0.7771 - val_loss: 1.0025 - val_acc: 0.7069

Epoch 00129: val_acc did not improve from 0.74138
Epoch 130/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6723 - acc: 0.8280 - val_loss: 6.7370 - val_acc: 0.3621

Epoch 00130: val_acc did not improve from 0.74138
Epoch 131/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8114 - acc: 0.7978 - val_loss: 1.2657 - val_acc: 0.7414

Epoch 00131: val_acc did not improve from 0.74138
Epoch 132/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9992 - acc: 0.7914 - val_loss: 6.6446 - val_acc: 0.3448

Epoch 00132: val_acc did not improve from 0.74138
Epoch 133/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7650 - acc: 0.8010 - val_loss: 4.4326 - val_acc: 0.4828

Epoch 00133: val_acc did not improve from 0.74138
Epoch 134/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8838 - acc: 0.7787 - val_loss: 3.1122 - val_acc: 0.5862

Epoch 00134: val_acc did not improve from 0.74138
Epoch 135/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9776 - acc: 0.7707 - val_loss: 0.9270 - val_acc: 0.7241

Epoch 00135: val_acc did not improve from 0.74138
Epoch 136/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9132 - acc: 0.7898 - val_loss: 3.0896 - val_acc: 0.6034

```
Epoch 00136: val_acc did not improve from 0.74138
Epoch 137/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8977 - acc: 0.7978 - val_loss: 0.9304 - val_acc: 0.
6379

Epoch 00137: val_acc did not improve from 0.74138
Epoch 138/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7232 - acc: 0.8073 - val_loss: 1.5879 - val_acc: 0.
7414

Epoch 00138: val_acc did not improve from 0.74138
Epoch 139/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7924 - acc: 0.7962 - val_loss: 1.6021 - val_acc: 0.
7069

Epoch 00139: val_acc did not improve from 0.74138
Epoch 140/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8833 - acc: 0.7978 - val_loss: 4.2221 - val_acc: 0.
5862

Epoch 00140: val_acc did not improve from 0.74138
Epoch 141/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8481 - acc: 0.7930 - val_loss: 4.3025 - val_acc: 0.
5690

Epoch 00141: val_acc did not improve from 0.74138
Epoch 142/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8020 - acc: 0.8392 - val_loss: 12.8870 - val_acc:
0.1207

Epoch 00142: val_acc did not improve from 0.74138
Epoch 143/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8813 - acc: 0.7739 - val_loss: 1.5270 - val_acc: 0.
6724

Epoch 00143: val_acc did not improve from 0.74138
Epoch 144/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8522 - acc: 0.7818 - val_loss: 8.9924 - val_acc: 0.
3103

Epoch 00144: val_acc did not improve from 0.74138
Epoch 145/300
```

```
157/157 [==============================] - 3s 16ms/step - loss: 1.0133 - acc: 0.7675 - val_loss: 1.1751 - val_acc: 0.
7241

Epoch 00145: val_acc did not improve from 0.74138
Epoch 146/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7923 - acc: 0.8137 - val_loss: 1.8929 - val_acc: 0.
5690

Epoch 00146: val_acc did not improve from 0.74138
Epoch 147/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8196 - acc: 0.8137 - val_loss: 1.3229 - val_acc: 0.
7414

Epoch 00147: val_acc did not improve from 0.74138
Epoch 148/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8818 - acc: 0.8010 - val_loss: 10.4983 - val_acc:
0.2069

Epoch 00148: val_acc did not improve from 0.74138
Epoch 149/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9231 - acc: 0.8026 - val_loss: 0.7709 - val_acc: 0.
7414

Epoch 00149: val_acc did not improve from 0.74138
Epoch 150/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7753 - acc: 0.8137 - val_loss: 1.2014 - val_acc: 0.
6897

Epoch 00150: val_acc did not improve from 0.74138
Epoch 151/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8638 - acc: 0.8264 - val_loss: 1.5338 - val_acc: 0.
7586

Epoch 00151: val_acc improved from 0.74138 to 0.75862, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 152/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9615 - acc: 0.8010 - val_loss: 5.4018 - val_acc: 0.
5517

Epoch 00152: val_acc did not improve from 0.75862
Epoch 153/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8463 - acc: 0.8041 - val_loss: 1.8295 - val_acc: 0.
```

```
6379

Epoch 00153: val_acc did not improve from 0.75862
Epoch 154/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9228 - acc: 0.8280 - val_loss: 10.4905 - val_acc:
0.2586

Epoch 00154: val_acc did not improve from 0.75862
Epoch 155/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8669 - acc: 0.8424 - val_loss: 1.7746 - val_acc: 0.
5862

Epoch 00155: val_acc did not improve from 0.75862
Epoch 156/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8630 - acc: 0.8264 - val_loss: 3.1805 - val_acc: 0.
6034

Epoch 00156: val_acc did not improve from 0.75862
Epoch 157/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8138 - acc: 0.8232 - val_loss: 11.0483 - val_acc:
0.2586

Epoch 00157: val_acc did not improve from 0.75862
Epoch 158/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0187 - acc: 0.8344 - val_loss: 6.3276 - val_acc: 0.
4483

Epoch 00158: val_acc did not improve from 0.75862
Epoch 159/300
157/157 [==============================] - 2s 16ms/step - loss: 0.7017 - acc: 0.8662 - val_loss: 7.0148 - val_acc: 0.
4138

Epoch 00159: val_acc did not improve from 0.75862
Epoch 160/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7935 - acc: 0.8217 - val_loss: 2.8005 - val_acc: 0.
6897

Epoch 00160: val_acc did not improve from 0.75862
Epoch 161/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7914 - acc: 0.8264 - val_loss: 1.5369 - val_acc: 0.
7414
```

```
Epoch 00161: val_acc did not improve from 0.75862
Epoch 162/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8807 - acc: 0.8344 - val_loss: 1.4163 - val_acc: 0.
6724


Epoch 00162: val_acc did not improve from 0.75862
Epoch 163/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8259 - acc: 0.8376 - val_loss: 2.7923 - val_acc: 0.
6034


Epoch 00163: val_acc did not improve from 0.75862
Epoch 164/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8889 - acc: 0.8439 - val_loss: 3.4984 - val_acc: 0.
5862


Epoch 00164: val_acc did not improve from 0.75862
Epoch 165/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7339 - acc: 0.8599 - val_loss: 6.5042 - val_acc: 0.
3793


Epoch 00165: val_acc did not improve from 0.75862
Epoch 166/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7046 - acc: 0.8487 - val_loss: 12.8136 - val_acc:
0.1724


Epoch 00166: val_acc did not improve from 0.75862
Epoch 167/300
157/157 [==============================] - 3s 17ms/step - loss: 0.9440 - acc: 0.8232 - val_loss: 5.5832 - val_acc: 0.
5172


Epoch 00167: val_acc did not improve from 0.75862
Epoch 168/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7850 - acc: 0.8360 - val_loss: 2.6674 - val_acc: 0.
7069


Epoch 00168: val_acc did not improve from 0.75862
Epoch 169/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8728 - acc: 0.8296 - val_loss: 2.1691 - val_acc: 0.
7414


Epoch 00169: val_acc did not improve from 0.75862
Epoch 170/300
```

```
157/157 [==============================] - 3s 16ms/step - loss: 0.8524 - acc: 0.8105 - val_loss: 1.6077 - val_acc: 0.
7414

Epoch 00170: val_acc did not improve from 0.75862
Epoch 171/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8222 - acc: 0.8615 - val_loss: 3.2637 - val_acc: 0.
6897

Epoch 00171: val_acc did not improve from 0.75862
Epoch 172/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8309 - acc: 0.8392 - val_loss: 2.1001 - val_acc: 0.
7586

Epoch 00172: val_acc did not improve from 0.75862
Epoch 173/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8279 - acc: 0.8471 - val_loss: 2.1234 - val_acc: 0.
7069

Epoch 00173: val_acc did not improve from 0.75862
Epoch 174/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0441 - acc: 0.8424 - val_loss: 1.1124 - val_acc: 0.
7414

Epoch 00174: val_acc did not improve from 0.75862
Epoch 175/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0120 - acc: 0.7962 - val_loss: 2.5355 - val_acc: 0.
6552

Epoch 00175: val_acc did not improve from 0.75862
Epoch 176/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7921 - acc: 0.8408 - val_loss: 1.4085 - val_acc: 0.
7586

Epoch 00176: val_acc did not improve from 0.75862
Epoch 177/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8467 - acc: 0.8439 - val_loss: 1.3320 - val_acc: 0.
6724

Epoch 00177: val_acc did not improve from 0.75862
Epoch 178/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9171 - acc: 0.8248 - val_loss: 6.9915 - val_acc: 0.
4655
```

```
Epoch 00178: val_acc did not improve from 0.75862
Epoch 179/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7412 - acc: 0.8360 - val_loss: 2.2788 - val_acc: 0.
7241

Epoch 00179: val_acc did not improve from 0.75862
Epoch 180/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6036 - acc: 0.8551 - val_loss: 1.8470 - val_acc: 0.
7069

Epoch 00180: val_acc did not improve from 0.75862
Epoch 181/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6189 - acc: 0.8503 - val_loss: 4.7176 - val_acc: 0.
6034

Epoch 00181: val_acc did not improve from 0.75862
Epoch 182/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8765 - acc: 0.8519 - val_loss: 1.6368 - val_acc: 0.
7241

Epoch 00182: val_acc did not improve from 0.75862
Epoch 183/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9666 - acc: 0.8280 - val_loss: 3.0367 - val_acc: 0.
6724

Epoch 00183: val_acc did not improve from 0.75862
Epoch 184/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0174 - acc: 0.8312 - val_loss: 2.4578 - val_acc: 0.
6897

Epoch 00184: val_acc did not improve from 0.75862
Epoch 185/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6936 - acc: 0.8551 - val_loss: 1.7757 - val_acc: 0.
6897

Epoch 00185: val_acc did not improve from 0.75862
Epoch 186/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8462 - acc: 0.8360 - val_loss: 6.1054 - val_acc: 0.
4310

Epoch 00186: val_acc did not improve from 0.75862
```

```
Epoch 187/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9081 - acc: 0.8455 - val_loss: 4.3798 - val_acc: 0.
5862

Epoch 00187: val_acc did not improve from 0.75862
Epoch 188/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7998 - acc: 0.8264 - val_loss: 1.7101 - val_acc: 0.
7759

Epoch 00188: val_acc improved from 0.75862 to 0.77586, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 189/300
157/157 [==============================] - 3s 17ms/step - loss: 0.6643 - acc: 0.8646 - val_loss: 1.2076 - val_acc: 0.
7241

Epoch 00189: val_acc did not improve from 0.77586
Epoch 190/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9299 - acc: 0.8169 - val_loss: 1.6454 - val_acc: 0.
7586

Epoch 00190: val_acc did not improve from 0.77586
Epoch 191/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7886 - acc: 0.8631 - val_loss: 2.2750 - val_acc: 0.
6552

Epoch 00191: val_acc did not improve from 0.77586
Epoch 192/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8382 - acc: 0.8822 - val_loss: 3.8576 - val_acc: 0.
6207

Epoch 00192: val_acc did not improve from 0.77586
Epoch 193/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9249 - acc: 0.8328 - val_loss: 6.7673 - val_acc: 0.
4138

Epoch 00193: val_acc did not improve from 0.77586
Epoch 194/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7728 - acc: 0.8408 - val_loss: 1.5494 - val_acc: 0.
7414

Epoch 00194: val_acc did not improve from 0.77586
Epoch 195/300
```

157/157 [==============================] - 3s 16ms/step - loss: 0.6190 - acc: 0.8790 - val_loss: 1.7360 - val_acc: 0.
7414

Epoch 00195: val_acc did not improve from 0.77586
Epoch 196/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7457 - acc: 0.8694 - val_loss: 6.1161 - val_acc: 0.
5172

Epoch 00196: val_acc did not improve from 0.77586
Epoch 197/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8397 - acc: 0.8392 - val_loss: 3.2000 - val_acc: 0.
6207

Epoch 00197: val_acc did not improve from 0.77586
Epoch 198/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8496 - acc: 0.8551 - val_loss: 1.7338 - val_acc: 0.
6552

Epoch 00198: val_acc did not improve from 0.77586
Epoch 199/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7713 - acc: 0.8790 - val_loss: 3.1925 - val_acc: 0.
6897

Epoch 00199: val_acc did not improve from 0.77586
Epoch 200/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8240 - acc: 0.8710 - val_loss: 2.3016 - val_acc: 0.
7241

Epoch 00200: val_acc did not improve from 0.77586
Epoch 201/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6859 - acc: 0.8917 - val_loss: 7.1909 - val_acc: 0.
4310

Epoch 00201: val_acc did not improve from 0.77586
Epoch 202/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7157 - acc: 0.8694 - val_loss: 3.0770 - val_acc: 0.
6897

Epoch 00202: val_acc did not improve from 0.77586
Epoch 203/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9138 - acc: 0.8567 - val_loss: 2.0870 - val_acc: 0.
7241

```
Epoch 00203: val_acc did not improve from 0.77586
Epoch 204/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7743 - acc: 0.8694 - val_loss: 1.7475 - val_acc: 0.
7586

Epoch 00204: val_acc did not improve from 0.77586
Epoch 205/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8287 - acc: 0.8838 - val_loss: 1.2832 - val_acc: 0.
7586

Epoch 00205: val_acc did not improve from 0.77586
Epoch 206/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8909 - acc: 0.8535 - val_loss: 2.7959 - val_acc: 0.
6724

Epoch 00206: val_acc did not improve from 0.77586
Epoch 207/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8205 - acc: 0.8599 - val_loss: 7.4871 - val_acc: 0.
4483

Epoch 00207: val_acc did not improve from 0.77586
Epoch 208/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7114 - acc: 0.8790 - val_loss: 2.3053 - val_acc: 0.
7759

Epoch 00208: val_acc did not improve from 0.77586
Epoch 209/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0240 - acc: 0.8822 - val_loss: 3.3314 - val_acc: 0.
7069

Epoch 00209: val_acc did not improve from 0.77586
Epoch 210/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0999 - acc: 0.8487 - val_loss: 6.3623 - val_acc: 0.
5000

Epoch 00210: val_acc did not improve from 0.77586
Epoch 211/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8482 - acc: 0.8853 - val_loss: 1.9465 - val_acc: 0.
7931

Epoch 00211: val_acc improved from 0.77586 to 0.79310, saving model to /content/drive/My Drive/Leaf Disease Classific
```

```
ation/Results/model_complex.h5
Epoch 212/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8392 - acc: 0.8838 - val_loss: 4.8732 - val_acc: 0.
6207

Epoch 00212: val_acc did not improve from 0.79310
Epoch 213/300
157/157 [==============================] - 3s 17ms/step - loss: 0.9313 - acc: 0.8631 - val_loss: 4.1780 - val_acc: 0.
6034

Epoch 00213: val_acc did not improve from 0.79310
Epoch 214/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9196 - acc: 0.8662 - val_loss: 1.9332 - val_acc: 0.
7069

Epoch 00214: val_acc did not improve from 0.79310
Epoch 215/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8037 - acc: 0.8838 - val_loss: 1.9258 - val_acc: 0.
8103

Epoch 00215: val_acc improved from 0.79310 to 0.81034, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 216/300
157/157 [==============================] - 3s 17ms/step - loss: 1.0262 - acc: 0.8710 - val_loss: 3.4625 - val_acc: 0.
7069

Epoch 00216: val_acc did not improve from 0.81034
Epoch 217/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9128 - acc: 0.8694 - val_loss: 4.8717 - val_acc: 0.
6207

Epoch 00217: val_acc did not improve from 0.81034
Epoch 218/300
157/157 [==============================] - 3s 16ms/step - loss: 1.3268 - acc: 0.8376 - val_loss: 5.4237 - val_acc: 0.
5517

Epoch 00218: val_acc did not improve from 0.81034
Epoch 219/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8686 - acc: 0.8599 - val_loss: 1.6596 - val_acc: 0.
8103

Epoch 00219: val_acc did not improve from 0.81034
```

```
Epoch 220/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9997 - acc: 0.8471 - val_loss: 1.9027 - val_acc: 0.
7586

Epoch 00220: val_acc did not improve from 0.81034
Epoch 221/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7808 - acc: 0.8662 - val_loss: 2.6262 - val_acc: 0.
6897

Epoch 00221: val_acc did not improve from 0.81034
Epoch 222/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7943 - acc: 0.8694 - val_loss: 1.2349 - val_acc: 0.
7414

Epoch 00222: val_acc did not improve from 0.81034
Epoch 223/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6869 - acc: 0.8662 - val_loss: 2.0935 - val_acc: 0.
7069

Epoch 00223: val_acc did not improve from 0.81034
Epoch 224/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8604 - acc: 0.8710 - val_loss: 4.3111 - val_acc: 0.
5517

Epoch 00224: val_acc did not improve from 0.81034
Epoch 225/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8021 - acc: 0.8885 - val_loss: 3.1467 - val_acc: 0.
7241

Epoch 00225: val_acc did not improve from 0.81034
Epoch 226/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8902 - acc: 0.8487 - val_loss: 2.1811 - val_acc: 0.
7241

Epoch 00226: val_acc did not improve from 0.81034
Epoch 227/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0931 - acc: 0.8408 - val_loss: 2.3508 - val_acc: 0.
6724

Epoch 00227: val_acc did not improve from 0.81034
Epoch 228/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7262 - acc: 0.8583 - val_loss: 4.8696 - val_acc: 0.
```

```
5517

Epoch 00228: val_acc did not improve from 0.81034
Epoch 229/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7980 - acc: 0.8901 - val_loss: 1.1696 - val_acc: 0.
7931

Epoch 00229: val_acc did not improve from 0.81034
Epoch 230/300
157/157 [==============================] - 3s 17ms/step - loss: 0.8610 - acc: 0.8615 - val_loss: 1.9133 - val_acc: 0.
6724

Epoch 00230: val_acc did not improve from 0.81034
Epoch 231/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9134 - acc: 0.8742 - val_loss: 2.6143 - val_acc: 0.
7586

Epoch 00231: val_acc did not improve from 0.81034
Epoch 232/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7642 - acc: 0.9013 - val_loss: 2.4482 - val_acc: 0.
7586

Epoch 00232: val_acc did not improve from 0.81034
Epoch 233/300
157/157 [==============================] - 3s 17ms/step - loss: 1.0564 - acc: 0.8758 - val_loss: 3.2738 - val_acc: 0.
7069

Epoch 00233: val_acc did not improve from 0.81034
Epoch 234/300
157/157 [==============================] - 3s 16ms/step - loss: 1.1841 - acc: 0.8519 - val_loss: 2.1462 - val_acc: 0.
7414

Epoch 00234: val_acc did not improve from 0.81034
Epoch 235/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7911 - acc: 0.8949 - val_loss: 1.7591 - val_acc: 0.
7241

Epoch 00235: val_acc did not improve from 0.81034
Epoch 236/300
157/157 [==============================] - 3s 16ms/step - loss: 0.5448 - acc: 0.9029 - val_loss: 1.5104 - val_acc: 0.
7759
```

```
Epoch 00236: val_acc did not improve from 0.81034
Epoch 237/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9023 - acc: 0.8710 - val_loss: 2.7907 - val_acc: 0.
6724


Epoch 00237: val_acc did not improve from 0.81034
Epoch 238/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6425 - acc: 0.8853 - val_loss: 3.4686 - val_acc: 0.
7414


Epoch 00238: val_acc did not improve from 0.81034
Epoch 239/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8490 - acc: 0.8678 - val_loss: 2.1178 - val_acc: 0.
7241


Epoch 00239: val_acc did not improve from 0.81034
Epoch 240/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8175 - acc: 0.8774 - val_loss: 3.3800 - val_acc: 0.
5517


Epoch 00240: val_acc did not improve from 0.81034
Epoch 241/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6724 - acc: 0.9060 - val_loss: 4.4570 - val_acc: 0.
6552


Epoch 00241: val_acc did not improve from 0.81034
Epoch 242/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9344 - acc: 0.8726 - val_loss: 3.6543 - val_acc: 0.
6034


Epoch 00242: val_acc did not improve from 0.81034
Epoch 243/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6331 - acc: 0.9029 - val_loss: 3.6839 - val_acc: 0.
5862


Epoch 00243: val_acc did not improve from 0.81034
Epoch 244/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7356 - acc: 0.8949 - val_loss: 3.0837 - val_acc: 0.
6724


Epoch 00244: val_acc did not improve from 0.81034
Epoch 245/300
```

```
157/157 [==============================] - 3s 16ms/step - loss: 0.8971 - acc: 0.8694 - val_loss: 1.9642 - val_acc: 0.
7241

Epoch 00245: val_acc did not improve from 0.81034
Epoch 246/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8438 - acc: 0.8694 - val_loss: 1.4138 - val_acc: 0.
7759

Epoch 00246: val_acc did not improve from 0.81034
Epoch 247/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6927 - acc: 0.9061 - val_loss: 3.6450 - val_acc: 0.
6379

Epoch 00247: val_acc did not improve from 0.81034
Epoch 248/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7839 - acc: 0.9029 - val_loss: 2.6153 - val_acc: 0.
7241

Epoch 00248: val_acc did not improve from 0.81034
Epoch 249/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7983 - acc: 0.8949 - val_loss: 2.2040 - val_acc: 0.
7759

Epoch 00249: val_acc did not improve from 0.81034
Epoch 250/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8656 - acc: 0.8965 - val_loss: 2.6214 - val_acc: 0.
7414

Epoch 00250: val_acc did not improve from 0.81034
Epoch 251/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8002 - acc: 0.8917 - val_loss: 1.5867 - val_acc: 0.
8448

Epoch 00251: val_acc improved from 0.81034 to 0.84483, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/model_complex.h5
Epoch 252/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7446 - acc: 0.8933 - val_loss: 2.7347 - val_acc: 0.
7414

Epoch 00252: val_acc did not improve from 0.84483
Epoch 253/300
157/157 [==============================] - 3s 17ms/step - loss: 0.7955 - acc: 0.8981 - val_loss: 1.9888 - val_acc: 0.
```

```
7931

Epoch 00253: val_acc did not improve from 0.84483
Epoch 254/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7481 - acc: 0.9013 - val_loss: 2.1379 - val_acc: 0.
7241

Epoch 00254: val_acc did not improve from 0.84483
Epoch 255/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9141 - acc: 0.8742 - val_loss: 2.8895 - val_acc: 0.
6379

Epoch 00255: val_acc did not improve from 0.84483
Epoch 256/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8357 - acc: 0.8933 - val_loss: 1.8905 - val_acc: 0.
7414

Epoch 00256: val_acc did not improve from 0.84483
Epoch 257/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7434 - acc: 0.9029 - val_loss: 3.9046 - val_acc: 0.
6379

Epoch 00257: val_acc did not improve from 0.84483
Epoch 258/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6637 - acc: 0.9029 - val_loss: 4.5363 - val_acc: 0.
5862

Epoch 00258: val_acc did not improve from 0.84483
Epoch 259/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8750 - acc: 0.8965 - val_loss: 2.3853 - val_acc: 0.
7414

Epoch 00259: val_acc did not improve from 0.84483
Epoch 260/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8484 - acc: 0.8901 - val_loss: 7.8021 - val_acc: 0.
3621

Epoch 00260: val_acc did not improve from 0.84483
Epoch 261/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0538 - acc: 0.8806 - val_loss: 2.9485 - val_acc: 0.
7586
```

```
Epoch 00261: val_acc did not improve from 0.84483
Epoch 262/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9274 - acc: 0.8885 - val_loss: 1.7888 - val_acc: 0.
7414

Epoch 00262: val_acc did not improve from 0.84483
Epoch 263/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7088 - acc: 0.9045 - val_loss: 1.3838 - val_acc: 0.
7759

Epoch 00263: val_acc did not improve from 0.84483
Epoch 264/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7946 - acc: 0.8806 - val_loss: 3.9626 - val_acc: 0.
6724

Epoch 00264: val_acc did not improve from 0.84483
Epoch 265/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7922 - acc: 0.9140 - val_loss: 3.6164 - val_acc: 0.
6724

Epoch 00265: val_acc did not improve from 0.84483
Epoch 266/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9659 - acc: 0.8933 - val_loss: 1.3919 - val_acc: 0.
7759

Epoch 00266: val_acc did not improve from 0.84483
Epoch 267/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8941 - acc: 0.8869 - val_loss: 9.2514 - val_acc: 0.
4138

Epoch 00267: val_acc did not improve from 0.84483
Epoch 268/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7968 - acc: 0.8838 - val_loss: 2.2459 - val_acc: 0.
7586

Epoch 00268: val_acc did not improve from 0.84483
Epoch 269/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0040 - acc: 0.8869 - val_loss: 2.8673 - val_acc: 0.
7414

Epoch 00269: val_acc did not improve from 0.84483
Epoch 270/300
```

```
157/157 [==============================] - 3s 17ms/step - loss: 0.7952 - acc: 0.9061 - val_loss: 3.7036 - val_acc: 0.
6379

Epoch 00270: val_acc did not improve from 0.84483
Epoch 271/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8338 - acc: 0.9108 - val_loss: 2.1081 - val_acc: 0.
7586

Epoch 00271: val_acc did not improve from 0.84483
Epoch 272/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7786 - acc: 0.9076 - val_loss: 2.1414 - val_acc: 0.
6897

Epoch 00272: val_acc did not improve from 0.84483
Epoch 273/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0980 - acc: 0.8774 - val_loss: 4.1051 - val_acc: 0.
6207

Epoch 00273: val_acc did not improve from 0.84483
Epoch 274/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6881 - acc: 0.9029 - val_loss: 4.0478 - val_acc: 0.
6552

Epoch 00274: val_acc did not improve from 0.84483
Epoch 275/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8387 - acc: 0.9013 - val_loss: 2.5455 - val_acc: 0.
6552

Epoch 00275: val_acc did not improve from 0.84483
Epoch 276/300
157/157 [==============================] - 3s 16ms/step - loss: 0.9635 - acc: 0.8742 - val_loss: 3.4013 - val_acc: 0.
7241

Epoch 00276: val_acc did not improve from 0.84483
Epoch 277/300
157/157 [==============================] - 3s 16ms/step - loss: 0.6756 - acc: 0.9188 - val_loss: 3.3740 - val_acc: 0.
7069

Epoch 00277: val_acc did not improve from 0.84483
Epoch 278/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8140 - acc: 0.9220 - val_loss: 5.7861 - val_acc: 0.
5345
```

```
Epoch 00278: val_acc did not improve from 0.84483
Epoch 279/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7750 - acc: 0.9076 - val_loss: 2.9038 - val_acc: 0.
7586

Epoch 00279: val_acc did not improve from 0.84483
Epoch 280/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7748 - acc: 0.9060 - val_loss: 1.9605 - val_acc: 0.
8276

Epoch 00280: val_acc did not improve from 0.84483
Epoch 281/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8086 - acc: 0.9013 - val_loss: 2.2044 - val_acc: 0.
7586

Epoch 00281: val_acc did not improve from 0.84483
Epoch 282/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0117 - acc: 0.8917 - val_loss: 2.4279 - val_acc: 0.
7241

Epoch 00282: val_acc did not improve from 0.84483
Epoch 283/300
157/157 [==============================] - 3s 16ms/step - loss: 0.5975 - acc: 0.9108 - val_loss: 4.3763 - val_acc: 0.
6724

Epoch 00283: val_acc did not improve from 0.84483
Epoch 284/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8836 - acc: 0.8981 - val_loss: 1.7044 - val_acc: 0.
7069

Epoch 00284: val_acc did not improve from 0.84483
Epoch 285/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8527 - acc: 0.9188 - val_loss: 3.0630 - val_acc: 0.
7241

Epoch 00285: val_acc did not improve from 0.84483
Epoch 286/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8602 - acc: 0.9029 - val_loss: 1.9678 - val_acc: 0.
7759

Epoch 00286: val_acc did not improve from 0.84483
```

```
Epoch 287/300
157/157 [==============================] - 3s 16ms/step - loss: 1.3850 - acc: 0.8662 - val_loss: 2.4699 - val_acc: 0.
7759

Epoch 00287: val_acc did not improve from 0.84483
Epoch 288/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7754 - acc: 0.9124 - val_loss: 3.3014 - val_acc: 0.
7414

Epoch 00288: val_acc did not improve from 0.84483
Epoch 289/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7339 - acc: 0.9140 - val_loss: 2.8195 - val_acc: 0.
7586

Epoch 00289: val_acc did not improve from 0.84483
Epoch 290/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8596 - acc: 0.9013 - val_loss: 3.9772 - val_acc: 0.
7069

Epoch 00290: val_acc did not improve from 0.84483
Epoch 291/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7244 - acc: 0.9013 - val_loss: 2.8593 - val_acc: 0.
7069

Epoch 00291: val_acc did not improve from 0.84483
Epoch 292/300
157/157 [==============================] - 3s 17ms/step - loss: 0.9280 - acc: 0.9060 - val_loss: 1.6119 - val_acc: 0.
7931

Epoch 00292: val_acc did not improve from 0.84483
Epoch 293/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0091 - acc: 0.8917 - val_loss: 5.1594 - val_acc: 0.
6379

Epoch 00293: val_acc did not improve from 0.84483
Epoch 294/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7855 - acc: 0.9108 - val_loss: 2.3849 - val_acc: 0.
6552

Epoch 00294: val_acc did not improve from 0.84483
Epoch 295/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7597 - acc: 0.8949 - val_loss: 3.7252 - val_acc: 0.
```

```
6724

Epoch 00295: val_acc did not improve from 0.84483
Epoch 296/300
157/157 [==============================] - 3s 16ms/step - loss: 0.5606 - acc: 0.9204 - val_loss: 8.5918 - val_acc: 0.
3793

Epoch 00296: val_acc did not improve from 0.84483
Epoch 297/300
157/157 [==============================] - 3s 16ms/step - loss: 1.0340 - acc: 0.8997 - val_loss: 8.3667 - val_acc: 0.
4310

Epoch 00297: val_acc did not improve from 0.84483
Epoch 298/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8796 - acc: 0.9077 - val_loss: 2.2723 - val_acc: 0.
7586

Epoch 00298: val_acc did not improve from 0.84483
Epoch 299/300
157/157 [==============================] - 3s 16ms/step - loss: 0.8877 - acc: 0.9092 - val_loss: 6.0229 - val_acc: 0.
5517

Epoch 00299: val_acc did not improve from 0.84483
Epoch 300/300
157/157 [==============================] - 3s 16ms/step - loss: 0.7884 - acc: 0.9108 - val_loss: 4.4744 - val_acc: 0.
6552

Epoch 00300: val_acc did not improve from 0.84483
```

```
In [0]: sns.set()
        plt.plot(history.history['acc'], 'r')
        plt.plot(history.history['val_acc'], 'b')
        plt.legend({'Train Accuracy': 'r', 'Test Accuracy':'b'})
        plt.show()
        plt.plot(history.history['loss'], 'r')
        plt.plot(history.history['val_loss'], 'b')
        plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
        plt.show()
```
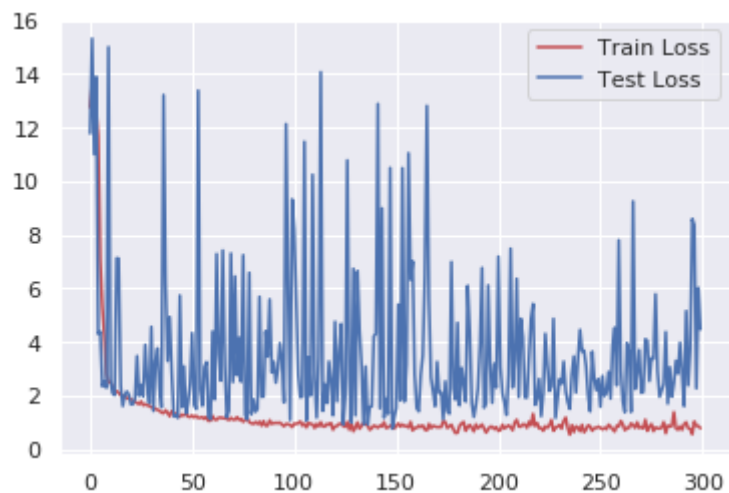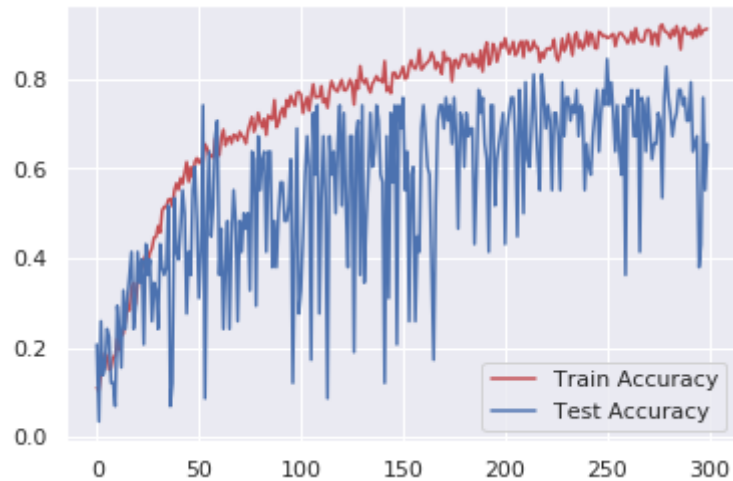
In [0]: `%load_ext tensorboard`

The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard

In [0]: `%tensorboard --logdir '/content/drive/My Drive/Leaf Disease Classification/Results/graph_complex'`

Output hidden; open in https://colab.research.google.com to view.

In [0]: `model1.load_weights(path+'Results/Results-Original/model_complex.h5')`

In [13]:
```python
y_pred_tr = model1.predict(X_train)

# Convering categorical representation of output classes into original classes(integers)
# Ex: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0] -> 1
y_tr2 = y_train.argmax(1)
y_pred_tr = y_pred_tr.argmax(1)

train_acc = accuracy_score(y_tr2, y_pred_tr)
print("Train Accuracy : ", train_acc)
```

Train Accuracy : 0.973015873015873

In [14]:
```python
y_pred = model1.predict(X_test)

# Convering categorical representation of output classes into original classes(integers)
# Ex: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0] -> 1
y_te2 = y_test.argmax(1)
y_pred = y_pred.argmax(1)

test_acc = accuracy_score(y_te2, y_pred)
print("Test Accuracy : ", test_acc)
```

Test Accuracy : 0.8448275862068966
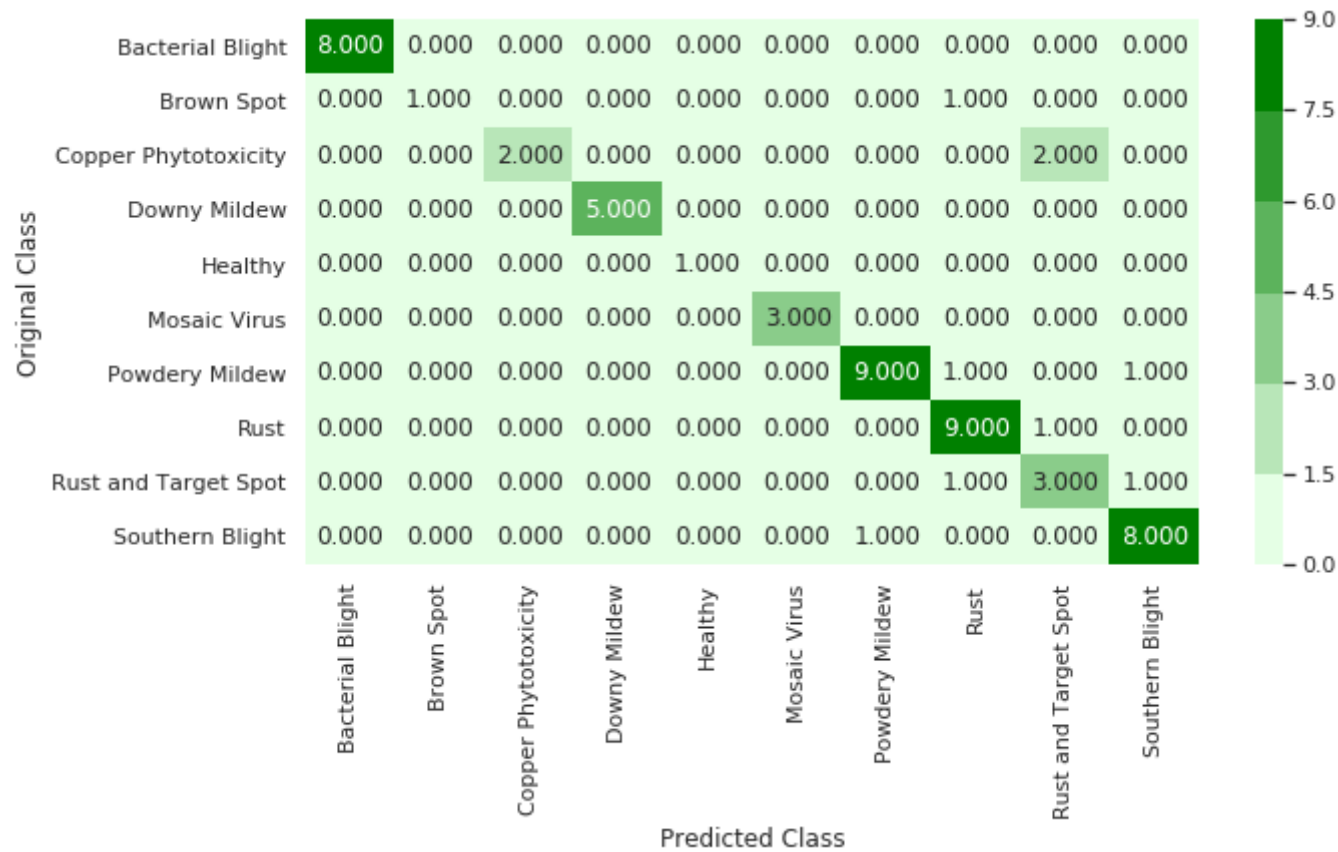
In [0]:
```
plot_confusion_matrix(test_y=y_te2, predict_y=y_pred, labels=folders)
```

```
Number of misclassified points  15.517241379310345
```
-- Confusion matrix --

-- Precision matrix --

Original Class	Bacterial Blight	Brown Spot	Copper Phytotoxicity	Downy Mildew	Healthy	Mosaic Virus	Powdery Mildew	Rust	Rust and Target Spot	Southern Blight
Bacterial Blight	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brown Spot	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.083	0.000	0.000
Copper Phytotoxicity	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.333	0.000
Downy Mildew	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
Healthy	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
Mosaic Virus	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000
Powdery Mildew	0.000	0.000	0.000	0.000	0.000	0.000	0.900	0.083	0.000	0.100
Rust	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.750	0.167	0.000
Rust and Target Spot	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.083	0.500	0.100
Southern Blight	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.800

Predicted Class

```
Sum of columns in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]
-------------------------------------------------- Recall matrix --------------------------------------------------
```

Sum of rows in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

Model 2

```
In [0]: # Saving model weights and other important parameters
        checkpoint = ModelCheckpoint(path+"Results/Results-Original/model_11.h5", monitor="val_acc",
                                mode="max", save_best_only=True, verbose=1)
        tensorboard = TensorBoard(log_dir=path+'Results/Results-Original/graph_11', histogram_freq=4, batch_size=4,
                                update_freq='epoch')

        callbacks = [checkpoint, tensorboard]
```

In [12]:
```python
model = Sequential()
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', strides=(2, 2),
                 kernel_initializer='he_normal', input_shape=input_shape))
model.add(Conv2D(64, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.3))

model.add(Conv2D(128, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(Conv2D(64, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.5))
model.add(Flatten())

model.add(Dense(128, activation='relu', kernel_initializer='he_normal'))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu', kernel_initializer='he_normal'))
model.add(Dense(num_classes, activation='softmax'))

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

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:66: The name tf.ge
t_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:541: The name tf.p
laceholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4479: The name tf.
truncated_normal is deprecated. Please use tf.random.truncated_normal instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4267: The name tf.
nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:148: The name tf.p
laceholder_with_default is deprecated. Please use tf.compat.v1.placeholder_with_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3733: calling drop
out (from tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4432: The name tf.
random_uniform is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793: The name tf.train.Optimizer i
s deprecated. Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3576: The name tf.
log is deprecated. Please use tf.math.log instead.

Model: "sequential_1"
_____
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 72, 72, 32)        896
_____
conv2d_2 (Conv2D)            (None, 72, 72, 64)        8256
_____
max_pooling2d_1 (MaxPooling2 (None, 36, 36, 64)        0
_____
dropout_1 (Dropout)          (None, 36, 36, 64)        0
_____
conv2d_3 (Conv2D)            (None, 36, 36, 128)       32896
```

```
_____
conv2d_4 (Conv2D)              (None, 36, 36, 64)         32832
_____
max_pooling2d_2 (MaxPooling2   (None, 18, 18, 64)         0
_____
dropout_2 (Dropout)            (None, 18, 18, 64)         0
_____
flatten_1 (Flatten)            (None, 20736)              0
_____
dense_1 (Dense)                (None, 128)                2654336
_____
dropout_3 (Dropout)            (None, 128)                0
_____
dense_2 (Dense)                (None, 64)                 8256
_____
dense_3 (Dense)                (None, 10)                 650
================================================================
Total params: 2,738,122
Trainable params: 2,738,122
Non-trainable params: 0
_____
```

In [13]:
```python
history = model.fit_generator(it_train, steps_per_epoch=steps,
                              epochs=250, validation_data=(X_test, y_test),
                              verbose=1, callbacks=callbacks)
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (from tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.assign is deprecated. Please use tf.compat.v1.assign instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3005: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:190: The name tf.get_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:197: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:207: The name tf.global_variables is deprecated. Please use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:216: The name tf.is_variable_initialized is deprecated. Please use tf.compat.v1.is_variable_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:223: The name tf.variables_initializer is deprecated. Please use tf.compat.v1.variables_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1068: The name tf.summary.histogram is deprecated. Please use tf.compat.v1.summary.histogram instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122: The name tf.summary.merge_all is deprecated. Please use tf.compat.v1.summary.merge_all instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125: The name tf.summary.FileWriter is deprecated. Please use tf.compat.v1.summary.FileWriter instead.

Epoch 1/250
157/157 [==============================] - 3s 21ms/step - loss: 4.0325 - acc: 0.0717 - val_loss: 2.3081 - val_acc: 0.1552

```
          Epoch 00001: val_acc improved from -inf to 0.15517, saving model to /content/drive/My Drive/Leaf Disease Classificati
          on/Results/Results-Original/model_11.h5
          WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265: The name tf.Summary is deprec
          ated. Please use tf.compat.v1.Summary instead.


          Epoch 2/250
          157/157 [==============================] - 2s 10ms/step - loss: 2.3159 - acc: 0.0860 - val_loss: 2.8490 - val_acc: 0.
          1379


          Epoch 00002: val_acc did not improve from 0.15517
          Epoch 3/250
          157/157 [==============================] - 2s 10ms/step - loss: 2.3166 - acc: 0.1354 - val_loss: 2.2690 - val_acc: 0.
          1724


          Epoch 00003: val_acc improved from 0.15517 to 0.17241, saving model to /content/drive/My Drive/Leaf Disease Classific
          ation/Results/Results-Original/model_11.h5
          Epoch 4/250
          157/157 [==============================] - 1s 10ms/step - loss: 2.1312 - acc: 0.2213 - val_loss: 1.6595 - val_acc: 0.
          4310


          Epoch 00004: val_acc improved from 0.17241 to 0.43103, saving model to /content/drive/My Drive/Leaf Disease Classific
          ation/Results/Results-Original/model_11.h5
          Epoch 5/250
          157/157 [==============================] - 2s 10ms/step - loss: 1.7897 - acc: 0.3408 - val_loss: 1.1799 - val_acc: 0.
          5690


          Epoch 00005: val_acc improved from 0.43103 to 0.56897, saving model to /content/drive/My Drive/Leaf Disease Classific
          ation/Results/Results-Original/model_11.h5
          Epoch 6/250
          157/157 [==============================] - 2s 10ms/step - loss: 1.4369 - acc: 0.4650 - val_loss: 1.0059 - val_acc: 0.
          5690


          Epoch 00006: val_acc did not improve from 0.56897
          Epoch 7/250
          157/157 [==============================] - 1s 10ms/step - loss: 1.3736 - acc: 0.5223 - val_loss: 1.0195 - val_acc: 0.
          6379


          Epoch 00007: val_acc improved from 0.56897 to 0.63793, saving model to /content/drive/My Drive/Leaf Disease Classific
          ation/Results/Results-Original/model_11.h5
          Epoch 8/250
          157/157 [==============================] - 2s 10ms/step - loss: 1.2554 - acc: 0.5446 - val_loss: 0.9616 - val_acc: 0.
          6207
```

```
Epoch 00008: val_acc did not improve from 0.63793
Epoch 9/250
157/157 [==============================] - 1s 10ms/step - loss: 1.1594 - acc: 0.5987 - val_loss: 0.8923 - val_acc: 0.
6207


Epoch 00009: val_acc did not improve from 0.63793
Epoch 10/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0335 - acc: 0.6290 - val_loss: 0.9819 - val_acc: 0.6
207


Epoch 00010: val_acc did not improve from 0.63793
Epoch 11/250
157/157 [==============================] - 1s 10ms/step - loss: 1.0114 - acc: 0.6513 - val_loss: 0.8840 - val_acc: 0.
7414


Epoch 00011: val_acc improved from 0.63793 to 0.74138, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Original/model_11.h5
Epoch 12/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8858 - acc: 0.6799 - val_loss: 1.2133 - val_acc: 0.6
034


Epoch 00012: val_acc did not improve from 0.74138
Epoch 13/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9002 - acc: 0.6656 - val_loss: 0.9234 - val_acc: 0.6
897


Epoch 00013: val_acc did not improve from 0.74138
Epoch 14/250
157/157 [==============================] - 2s 10ms/step - loss: 0.8420 - acc: 0.6974 - val_loss: 0.9999 - val_acc: 0.
6207


Epoch 00014: val_acc did not improve from 0.74138
Epoch 15/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7952 - acc: 0.6943 - val_loss: 0.8592 - val_acc: 0.7
241


Epoch 00015: val_acc did not improve from 0.74138
Epoch 16/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7952 - acc: 0.7245 - val_loss: 1.0189 - val_acc: 0.6
552
```

```
Epoch 00016: val_acc did not improve from 0.74138
Epoch 17/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7308 - acc: 0.7436 - val_loss: 2.6915 - val_acc: 0.4
310

Epoch 00017: val_acc did not improve from 0.74138
Epoch 18/250
157/157 [==============================] - 2s 10ms/step - loss: 0.7016 - acc: 0.7357 - val_loss: 1.1026 - val_acc: 0.
6724

Epoch 00018: val_acc did not improve from 0.74138
Epoch 19/250
157/157 [==============================] - 1s 10ms/step - loss: 0.7310 - acc: 0.7373 - val_loss: 0.9135 - val_acc: 0.
6379

Epoch 00019: val_acc did not improve from 0.74138
Epoch 20/250
157/157 [==============================] - 2s 10ms/step - loss: 0.6392 - acc: 0.7516 - val_loss: 1.0864 - val_acc: 0.
6724

Epoch 00020: val_acc did not improve from 0.74138
Epoch 21/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6829 - acc: 0.7484 - val_loss: 0.9500 - val_acc: 0.6
897

Epoch 00021: val_acc did not improve from 0.74138
Epoch 22/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6666 - acc: 0.7723 - val_loss: 1.2808 - val_acc: 0.5
862

Epoch 00022: val_acc did not improve from 0.74138
Epoch 23/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6157 - acc: 0.7930 - val_loss: 1.0221 - val_acc: 0.6
897

Epoch 00023: val_acc did not improve from 0.74138
Epoch 24/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6612 - acc: 0.7739 - val_loss: 1.0826 - val_acc: 0.6
379

Epoch 00024: val_acc did not improve from 0.74138
Epoch 25/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 0.5343 - acc: 0.8089 - val_loss: 1.0158 - val_acc: 0.6
379

Epoch 00025: val_acc did not improve from 0.74138
Epoch 26/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5208 - acc: 0.8169 - val_loss: 1.3392 - val_acc: 0.5
517

Epoch 00026: val_acc did not improve from 0.74138
Epoch 27/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6080 - acc: 0.7755 - val_loss: 1.0773 - val_acc: 0.6
552

Epoch 00027: val_acc did not improve from 0.74138
Epoch 28/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5350 - acc: 0.8137 - val_loss: 1.2150 - val_acc: 0.5
862

Epoch 00028: val_acc did not improve from 0.74138
Epoch 29/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5217 - acc: 0.8169 - val_loss: 1.0784 - val_acc: 0.7
586

Epoch 00029: val_acc improved from 0.74138 to 0.75862, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Original/model_11.h5
Epoch 30/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5341 - acc: 0.7994 - val_loss: 1.2558 - val_acc: 0.6
207

Epoch 00030: val_acc did not improve from 0.75862
Epoch 31/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5295 - acc: 0.8280 - val_loss: 0.9769 - val_acc: 0.7
241

Epoch 00031: val_acc did not improve from 0.75862
Epoch 32/250
157/157 [==============================] - 2s 10ms/step - loss: 0.4775 - acc: 0.8360 - val_loss: 1.6214 - val_acc: 0.
6379

Epoch 00032: val_acc did not improve from 0.75862
Epoch 33/250
157/157 [==============================] - 2s 10ms/step - loss: 0.4924 - acc: 0.8328 - val_loss: 1.3530 - val_acc: 0.
```

```
7069

Epoch 00033: val_acc did not improve from 0.75862
Epoch 34/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5828 - acc: 0.8121 - val_loss: 1.2976 - val_acc: 0.6
379

Epoch 00034: val_acc did not improve from 0.75862
Epoch 35/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4912 - acc: 0.8440 - val_loss: 0.9332 - val_acc: 0.7
241

Epoch 00035: val_acc did not improve from 0.75862
Epoch 36/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4892 - acc: 0.8408 - val_loss: 1.3474 - val_acc: 0.6
552

Epoch 00036: val_acc did not improve from 0.75862
Epoch 37/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4972 - acc: 0.8408 - val_loss: 1.0700 - val_acc: 0.7
069

Epoch 00037: val_acc did not improve from 0.75862
Epoch 38/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4882 - acc: 0.8344 - val_loss: 1.1121 - val_acc: 0.6
724

Epoch 00038: val_acc did not improve from 0.75862
Epoch 39/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5284 - acc: 0.8328 - val_loss: 1.2984 - val_acc: 0.7
414

Epoch 00039: val_acc did not improve from 0.75862
Epoch 40/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4636 - acc: 0.8615 - val_loss: 1.1850 - val_acc: 0.7
241

Epoch 00040: val_acc did not improve from 0.75862
Epoch 41/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5844 - acc: 0.8424 - val_loss: 0.9219 - val_acc: 0.7
069
```

```
Epoch 00041: val_acc did not improve from 0.75862
Epoch 42/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4404 - acc: 0.8631 - val_loss: 0.9289 - val_acc: 0.7
586

Epoch 00042: val_acc did not improve from 0.75862
Epoch 43/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4743 - acc: 0.8392 - val_loss: 1.1709 - val_acc: 0.6
379

Epoch 00043: val_acc did not improve from 0.75862
Epoch 44/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4478 - acc: 0.8726 - val_loss: 0.9946 - val_acc: 0.6
897

Epoch 00044: val_acc did not improve from 0.75862
Epoch 45/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4828 - acc: 0.8694 - val_loss: 1.0818 - val_acc: 0.7
069

Epoch 00045: val_acc did not improve from 0.75862
Epoch 46/250
157/157 [==============================] - 2s 10ms/step - loss: 0.4641 - acc: 0.8567 - val_loss: 0.9038 - val_acc: 0.
7069

Epoch 00046: val_acc did not improve from 0.75862
Epoch 47/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4607 - acc: 0.8615 - val_loss: 1.4848 - val_acc: 0.7
241

Epoch 00047: val_acc did not improve from 0.75862
Epoch 48/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4546 - acc: 0.8695 - val_loss: 1.3663 - val_acc: 0.6
724

Epoch 00048: val_acc did not improve from 0.75862
Epoch 49/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4224 - acc: 0.8662 - val_loss: 1.2553 - val_acc: 0.6
552

Epoch 00049: val_acc did not improve from 0.75862
Epoch 50/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 0.4415 - acc: 0.8583 - val_loss: 1.1110 - val_acc: 0.7
241

Epoch 00050: val_acc did not improve from 0.75862
Epoch 51/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5279 - acc: 0.8360 - val_loss: 1.4822 - val_acc: 0.6
724

Epoch 00051: val_acc did not improve from 0.75862
Epoch 52/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4971 - acc: 0.8631 - val_loss: 1.2488 - val_acc: 0.6
897

Epoch 00052: val_acc did not improve from 0.75862
Epoch 53/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5394 - acc: 0.8360 - val_loss: 0.8878 - val_acc: 0.7
241

Epoch 00053: val_acc did not improve from 0.75862
Epoch 54/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4642 - acc: 0.8758 - val_loss: 1.1749 - val_acc: 0.6
724

Epoch 00054: val_acc did not improve from 0.75862
Epoch 55/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4647 - acc: 0.8551 - val_loss: 1.1791 - val_acc: 0.7
241

Epoch 00055: val_acc did not improve from 0.75862
Epoch 56/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4735 - acc: 0.8551 - val_loss: 0.9489 - val_acc: 0.7
414

Epoch 00056: val_acc did not improve from 0.75862
Epoch 57/250
157/157 [==============================] - 2s 10ms/step - loss: 0.4805 - acc: 0.8503 - val_loss: 1.1030 - val_acc: 0.
7414

Epoch 00057: val_acc did not improve from 0.75862
Epoch 58/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5492 - acc: 0.8439 - val_loss: 1.3480 - val_acc: 0.7
414
```

```
Epoch 00058: val_acc did not improve from 0.75862
Epoch 59/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5208 - acc: 0.8424 - val_loss: 1.2757 - val_acc: 0.6
897

Epoch 00059: val_acc did not improve from 0.75862
Epoch 60/250
157/157 [==============================] - 1s 10ms/step - loss: 0.5462 - acc: 0.8631 - val_loss: 1.2432 - val_acc: 0.
6897

Epoch 00060: val_acc did not improve from 0.75862
Epoch 61/250
157/157 [==============================] - 1s 9ms/step - loss: 0.3752 - acc: 0.8583 - val_loss: 0.9399 - val_acc: 0.7
414

Epoch 00061: val_acc did not improve from 0.75862
Epoch 62/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4455 - acc: 0.8710 - val_loss: 0.8978 - val_acc: 0.7
414

Epoch 00062: val_acc did not improve from 0.75862
Epoch 63/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4956 - acc: 0.8710 - val_loss: 1.9096 - val_acc: 0.6
552

Epoch 00063: val_acc did not improve from 0.75862
Epoch 64/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4736 - acc: 0.8758 - val_loss: 0.9822 - val_acc: 0.7
069

Epoch 00064: val_acc did not improve from 0.75862
Epoch 65/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4007 - acc: 0.8806 - val_loss: 1.5569 - val_acc: 0.7
414

Epoch 00065: val_acc did not improve from 0.75862
Epoch 66/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4873 - acc: 0.8471 - val_loss: 2.1073 - val_acc: 0.6
897

Epoch 00066: val_acc did not improve from 0.75862
```

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Epoch 67/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5968 - acc: 0.8710 - val_loss: 1.8458 - val_acc: 0.6
897

Epoch 00067: val_acc did not improve from 0.75862
Epoch 68/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5253 - acc: 0.8710 - val_loss: 1.3540 - val_acc: 0.7
241

Epoch 00068: val_acc did not improve from 0.75862
Epoch 69/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4642 - acc: 0.8726 - val_loss: 1.7053 - val_acc: 0.6
724

Epoch 00069: val_acc did not improve from 0.75862
Epoch 70/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5032 - acc: 0.8726 - val_loss: 0.8437 - val_acc: 0.6
897

Epoch 00070: val_acc did not improve from 0.75862
Epoch 71/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5056 - acc: 0.8424 - val_loss: 1.6002 - val_acc: 0.6
724

Epoch 00071: val_acc did not improve from 0.75862
Epoch 72/250
157/157 [==============================] - 1s 10ms/step - loss: 0.4002 - acc: 0.8885 - val_loss: 1.6630 - val_acc: 0.
7414

Epoch 00072: val_acc did not improve from 0.75862
Epoch 73/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5162 - acc: 0.8646 - val_loss: 1.2270 - val_acc: 0.6
897

Epoch 00073: val_acc did not improve from 0.75862
Epoch 74/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5219 - acc: 0.8901 - val_loss: 1.5023 - val_acc: 0.7
069

Epoch 00074: val_acc did not improve from 0.75862
Epoch 75/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6289 - acc: 0.8758 - val_loss: 1.2474 - val_acc: 0.7
```

069

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Epoch 00075: val_acc did not improve from 0.75862
Epoch 76/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5636 - acc: 0.8551 - val_loss: 1.6320 - val_acc: 0.6
724

Epoch 00076: val_acc did not improve from 0.75862
Epoch 77/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5129 - acc: 0.8726 - val_loss: 1.2629 - val_acc: 0.7
069

Epoch 00077: val_acc did not improve from 0.75862
Epoch 78/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4318 - acc: 0.8583 - val_loss: 1.0596 - val_acc: 0.6
724

Epoch 00078: val_acc did not improve from 0.75862
Epoch 79/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4842 - acc: 0.8583 - val_loss: 1.3479 - val_acc: 0.7
241

Epoch 00079: val_acc did not improve from 0.75862
Epoch 80/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4316 - acc: 0.8726 - val_loss: 2.0225 - val_acc: 0.6
552

Epoch 00080: val_acc did not improve from 0.75862
Epoch 81/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5804 - acc: 0.8376 - val_loss: 1.3256 - val_acc: 0.6
897

Epoch 00081: val_acc did not improve from 0.75862
Epoch 82/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4727 - acc: 0.8599 - val_loss: 1.7153 - val_acc: 0.6
724

Epoch 00082: val_acc did not improve from 0.75862
Epoch 83/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4763 - acc: 0.8933 - val_loss: 1.7508 - val_acc: 0.6
552
```

```
Epoch 00083: val_acc did not improve from 0.75862
Epoch 84/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5671 - acc: 0.8392 - val_loss: 1.2085 - val_acc: 0.6
897


Epoch 00084: val_acc did not improve from 0.75862
Epoch 85/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6564 - acc: 0.8694 - val_loss: 0.8133 - val_acc: 0.7
241


Epoch 00085: val_acc did not improve from 0.75862
Epoch 86/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5779 - acc: 0.8424 - val_loss: 1.1041 - val_acc: 0.7
069


Epoch 00086: val_acc did not improve from 0.75862
Epoch 87/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5537 - acc: 0.8615 - val_loss: 2.0950 - val_acc: 0.7
069


Epoch 00087: val_acc did not improve from 0.75862
Epoch 88/250
157/157 [==============================] - 1s 10ms/step - loss: 0.4781 - acc: 0.8694 - val_loss: 1.5053 - val_acc: 0.
6897


Epoch 00088: val_acc did not improve from 0.75862
Epoch 89/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6572 - acc: 0.8408 - val_loss: 0.8955 - val_acc: 0.7
069


Epoch 00089: val_acc did not improve from 0.75862
Epoch 90/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5191 - acc: 0.8790 - val_loss: 0.9934 - val_acc: 0.6
897


Epoch 00090: val_acc did not improve from 0.75862
Epoch 91/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5844 - acc: 0.8392 - val_loss: 1.1099 - val_acc: 0.6
897


Epoch 00091: val_acc did not improve from 0.75862
Epoch 92/250
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157/157 [==============================] - 1s 9ms/step - loss: 0.5800 - acc: 0.8503 - val_loss: 1.9449 - val_acc: 0.6
897

Epoch 00092: val_acc did not improve from 0.75862
Epoch 93/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6254 - acc: 0.8567 - val_loss: 1.4531 - val_acc: 0.6
379

Epoch 00093: val_acc did not improve from 0.75862
Epoch 94/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6815 - acc: 0.8471 - val_loss: 1.7562 - val_acc: 0.7
069

Epoch 00094: val_acc did not improve from 0.75862
Epoch 95/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5005 - acc: 0.8599 - val_loss: 2.0013 - val_acc: 0.6
897

Epoch 00095: val_acc did not improve from 0.75862
Epoch 96/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4915 - acc: 0.8710 - val_loss: 1.7579 - val_acc: 0.6
897

Epoch 00096: val_acc did not improve from 0.75862
Epoch 97/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6668 - acc: 0.8631 - val_loss: 1.3560 - val_acc: 0.6
897

Epoch 00097: val_acc did not improve from 0.75862
Epoch 98/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6350 - acc: 0.8567 - val_loss: 0.7958 - val_acc: 0.6
897

Epoch 00098: val_acc did not improve from 0.75862
Epoch 99/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5246 - acc: 0.8710 - val_loss: 2.2996 - val_acc: 0.7
069

Epoch 00099: val_acc did not improve from 0.75862
Epoch 100/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5404 - acc: 0.8583 - val_loss: 0.9797 - val_acc: 0.7
069
```

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       Epoch 00100: val_acc did not improve from 0.75862
       Epoch 101/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.5578 - acc: 0.8774 - val_loss: 0.8911 - val_acc: 0.6
       897

       Epoch 00101: val_acc did not improve from 0.75862
       Epoch 102/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.4739 - acc: 0.8885 - val_loss: 0.9961 - val_acc: 0.6
       897

       Epoch 00102: val_acc did not improve from 0.75862
       Epoch 103/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.5932 - acc: 0.8360 - val_loss: 1.4773 - val_acc: 0.7
       069

       Epoch 00103: val_acc did not improve from 0.75862
       Epoch 104/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.6053 - acc: 0.8615 - val_loss: 1.1817 - val_acc: 0.6
       724

       Epoch 00104: val_acc did not improve from 0.75862
       Epoch 105/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.5508 - acc: 0.8854 - val_loss: 1.2749 - val_acc: 0.7
       069

       Epoch 00105: val_acc did not improve from 0.75862
       Epoch 106/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.6839 - acc: 0.8471 - val_loss: 1.1974 - val_acc: 0.7
       414

       Epoch 00106: val_acc did not improve from 0.75862
       Epoch 107/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.4858 - acc: 0.8726 - val_loss: 1.0100 - val_acc: 0.6
       897

       Epoch 00107: val_acc did not improve from 0.75862
       Epoch 108/250
       157/157 [==============================] - 1s 9ms/step - loss: 0.5764 - acc: 0.8694 - val_loss: 1.3865 - val_acc: 0.7
       069

       Epoch 00108: val_acc did not improve from 0.75862
```

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Epoch 109/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7165 - acc: 0.8248 - val_loss: 1.0850 - val_acc: 0.6
897

Epoch 00109: val_acc did not improve from 0.75862
Epoch 110/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6236 - acc: 0.8535 - val_loss: 1.5037 - val_acc: 0.7
241

Epoch 00110: val_acc did not improve from 0.75862
Epoch 111/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5139 - acc: 0.8694 - val_loss: 1.3384 - val_acc: 0.7
414

Epoch 00111: val_acc did not improve from 0.75862
Epoch 112/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7423 - acc: 0.8631 - val_loss: 1.2707 - val_acc: 0.6
207

Epoch 00112: val_acc did not improve from 0.75862
Epoch 113/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6365 - acc: 0.8631 - val_loss: 1.0890 - val_acc: 0.7
241

Epoch 00113: val_acc did not improve from 0.75862
Epoch 114/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6092 - acc: 0.8726 - val_loss: 0.9942 - val_acc: 0.7
069

Epoch 00114: val_acc did not improve from 0.75862
Epoch 115/250
157/157 [==============================] - 2s 10ms/step - loss: 0.5979 - acc: 0.8694 - val_loss: 1.8464 - val_acc: 0.
7241

Epoch 00115: val_acc did not improve from 0.75862
Epoch 116/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6117 - acc: 0.8408 - val_loss: 1.3156 - val_acc: 0.7
586

Epoch 00116: val_acc did not improve from 0.75862
Epoch 117/250
157/157 [==============================] - 2s 10ms/step - loss: 0.7417 - acc: 0.8408 - val_loss: 1.4403 - val_acc: 0.
```

6897

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Epoch 00117: val_acc did not improve from 0.75862
Epoch 118/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4808 - acc: 0.8822 - val_loss: 1.6879 - val_acc: 0.6
897

Epoch 00118: val_acc did not improve from 0.75862
Epoch 119/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7774 - acc: 0.8424 - val_loss: 2.0480 - val_acc: 0.7
241

Epoch 00119: val_acc did not improve from 0.75862
Epoch 120/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5848 - acc: 0.8599 - val_loss: 4.1360 - val_acc: 0.6
034

Epoch 00120: val_acc did not improve from 0.75862
Epoch 121/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7686 - acc: 0.8710 - val_loss: 1.1681 - val_acc: 0.7
241

Epoch 00121: val_acc did not improve from 0.75862
Epoch 122/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6400 - acc: 0.8424 - val_loss: 1.2956 - val_acc: 0.6
897

Epoch 00122: val_acc did not improve from 0.75862
Epoch 123/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6931 - acc: 0.8519 - val_loss: 0.8991 - val_acc: 0.7
414

Epoch 00123: val_acc did not improve from 0.75862
Epoch 124/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5257 - acc: 0.8742 - val_loss: 2.0999 - val_acc: 0.5
862

Epoch 00124: val_acc did not improve from 0.75862
Epoch 125/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6450 - acc: 0.8439 - val_loss: 1.8408 - val_acc: 0.6
207
```

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Epoch 00125: val_acc did not improve from 0.75862
Epoch 126/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6140 - acc: 0.8551 - val_loss: 1.8026 - val_acc: 0.6
897

Epoch 00126: val_acc did not improve from 0.75862
Epoch 127/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6220 - acc: 0.8551 - val_loss: 1.3403 - val_acc: 0.6
724

Epoch 00127: val_acc did not improve from 0.75862
Epoch 128/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6208 - acc: 0.8806 - val_loss: 1.3315 - val_acc: 0.7
241

Epoch 00128: val_acc did not improve from 0.75862
Epoch 129/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6778 - acc: 0.8185 - val_loss: 1.3696 - val_acc: 0.6
552

Epoch 00129: val_acc did not improve from 0.75862
Epoch 130/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9587 - acc: 0.8344 - val_loss: 1.5106 - val_acc: 0.6
897

Epoch 00130: val_acc did not improve from 0.75862
Epoch 131/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5934 - acc: 0.8615 - val_loss: 1.2732 - val_acc: 0.6
724

Epoch 00131: val_acc did not improve from 0.75862
Epoch 132/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6628 - acc: 0.8646 - val_loss: 1.1907 - val_acc: 0.5
345

Epoch 00132: val_acc did not improve from 0.75862
Epoch 133/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5976 - acc: 0.8742 - val_loss: 0.9896 - val_acc: 0.7
069

Epoch 00133: val_acc did not improve from 0.75862
Epoch 134/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 0.5627 - acc: 0.8583 - val_loss: 1.2908 - val_acc: 0.6
897

Epoch 00134: val_acc did not improve from 0.75862
Epoch 135/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6770 - acc: 0.8869 - val_loss: 1.2361 - val_acc: 0.7
069

Epoch 00135: val_acc did not improve from 0.75862
Epoch 136/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5569 - acc: 0.8392 - val_loss: 2.0928 - val_acc: 0.6
724

Epoch 00136: val_acc did not improve from 0.75862
Epoch 137/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7518 - acc: 0.8615 - val_loss: 1.2560 - val_acc: 0.5
690

Epoch 00137: val_acc did not improve from 0.75862
Epoch 138/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6272 - acc: 0.8471 - val_loss: 1.3262 - val_acc: 0.7
241

Epoch 00138: val_acc did not improve from 0.75862
Epoch 139/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6541 - acc: 0.8710 - val_loss: 1.6460 - val_acc: 0.7
241

Epoch 00139: val_acc did not improve from 0.75862
Epoch 140/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7519 - acc: 0.8408 - val_loss: 1.4003 - val_acc: 0.5
690

Epoch 00140: val_acc did not improve from 0.75862
Epoch 141/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6032 - acc: 0.8742 - val_loss: 2.4724 - val_acc: 0.6
897

Epoch 00141: val_acc did not improve from 0.75862
Epoch 142/250
157/157 [==============================] - 2s 10ms/step - loss: 0.6372 - acc: 0.8615 - val_loss: 1.5204 - val_acc: 0.
6552
```

```
Epoch 00142: val_acc did not improve from 0.75862
Epoch 143/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9386 - acc: 0.8535 - val_loss: 1.4313 - val_acc: 0.6
897

Epoch 00143: val_acc did not improve from 0.75862
Epoch 144/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7027 - acc: 0.8567 - val_loss: 1.2102 - val_acc: 0.7
241

Epoch 00144: val_acc did not improve from 0.75862
Epoch 145/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7504 - acc: 0.8392 - val_loss: 1.2170 - val_acc: 0.6
897

Epoch 00145: val_acc did not improve from 0.75862
Epoch 146/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7496 - acc: 0.8455 - val_loss: 1.1322 - val_acc: 0.6
897

Epoch 00146: val_acc did not improve from 0.75862
Epoch 147/250
157/157 [==============================] - 1s 10ms/step - loss: 1.0016 - acc: 0.8344 - val_loss: 1.1294 - val_acc: 0.
6552

Epoch 00147: val_acc did not improve from 0.75862
Epoch 148/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8112 - acc: 0.8487 - val_loss: 2.3780 - val_acc: 0.6
897

Epoch 00148: val_acc did not improve from 0.75862
Epoch 149/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6386 - acc: 0.8631 - val_loss: 2.3287 - val_acc: 0.6
552

Epoch 00149: val_acc did not improve from 0.75862
Epoch 150/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6794 - acc: 0.8917 - val_loss: 1.0802 - val_acc: 0.6
724

Epoch 00150: val_acc did not improve from 0.75862
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Epoch 151/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5632 - acc: 0.8551 - val_loss: 1.8749 - val_acc: 0.6
552

Epoch 00151: val_acc did not improve from 0.75862
Epoch 152/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6596 - acc: 0.8519 - val_loss: 1.0644 - val_acc: 0.6
207

Epoch 00152: val_acc did not improve from 0.75862
Epoch 153/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6780 - acc: 0.8694 - val_loss: 1.3154 - val_acc: 0.6
552

Epoch 00153: val_acc did not improve from 0.75862
Epoch 154/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6290 - acc: 0.8646 - val_loss: 1.6750 - val_acc: 0.6
379

Epoch 00154: val_acc did not improve from 0.75862
Epoch 155/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7133 - acc: 0.8758 - val_loss: 1.1984 - val_acc: 0.7
241

Epoch 00155: val_acc did not improve from 0.75862
Epoch 156/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7079 - acc: 0.8646 - val_loss: 1.4829 - val_acc: 0.6
552

Epoch 00156: val_acc did not improve from 0.75862
Epoch 157/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6485 - acc: 0.8726 - val_loss: 1.8151 - val_acc: 0.6
552

Epoch 00157: val_acc did not improve from 0.75862
Epoch 158/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7098 - acc: 0.8646 - val_loss: 1.0959 - val_acc: 0.7
241

Epoch 00158: val_acc did not improve from 0.75862
Epoch 159/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7961 - acc: 0.8408 - val_loss: 1.7065 - val_acc: 0.7
```

241

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Epoch 00159: val_acc did not improve from 0.75862
Epoch 160/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7080 - acc: 0.8631 - val_loss: 1.4981 - val_acc: 0.7
241

Epoch 00160: val_acc did not improve from 0.75862
Epoch 161/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6153 - acc: 0.8328 - val_loss: 1.4966 - val_acc: 0.6
207

Epoch 00161: val_acc did not improve from 0.75862
Epoch 162/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6069 - acc: 0.8615 - val_loss: 3.2845 - val_acc: 0.5
345

Epoch 00162: val_acc did not improve from 0.75862
Epoch 163/250
157/157 [==============================] - 2s 10ms/step - loss: 0.7744 - acc: 0.8678 - val_loss: 2.1123 - val_acc: 0.
7414

Epoch 00163: val_acc did not improve from 0.75862
Epoch 164/250
157/157 [==============================] - 1s 10ms/step - loss: 0.7013 - acc: 0.8726 - val_loss: 2.1230 - val_acc: 0.
7069

Epoch 00164: val_acc did not improve from 0.75862
Epoch 165/250
157/157 [==============================] - 1s 10ms/step - loss: 0.6745 - acc: 0.8631 - val_loss: 2.5639 - val_acc: 0.
5862

Epoch 00165: val_acc did not improve from 0.75862
Epoch 166/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8434 - acc: 0.8137 - val_loss: 1.0915 - val_acc: 0.6
379

Epoch 00166: val_acc did not improve from 0.75862
Epoch 167/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9769 - acc: 0.8551 - val_loss: 1.8904 - val_acc: 0.6
379
```

```
Epoch 00167: val_acc did not improve from 0.75862
Epoch 168/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7120 - acc: 0.8455 - val_loss: 2.5327 - val_acc: 0.6
379

Epoch 00168: val_acc did not improve from 0.75862
Epoch 169/250
157/157 [==============================] - 1s 10ms/step - loss: 0.7151 - acc: 0.8615 - val_loss: 2.1646 - val_acc: 0.
6897

Epoch 00169: val_acc did not improve from 0.75862
Epoch 170/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9147 - acc: 0.8360 - val_loss: 1.1723 - val_acc: 0.6
724

Epoch 00170: val_acc did not improve from 0.75862
Epoch 171/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7136 - acc: 0.8487 - val_loss: 2.5529 - val_acc: 0.6
724

Epoch 00171: val_acc did not improve from 0.75862
Epoch 172/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8011 - acc: 0.8392 - val_loss: 1.6931 - val_acc: 0.6
724

Epoch 00172: val_acc did not improve from 0.75862
Epoch 173/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8419 - acc: 0.8439 - val_loss: 2.4215 - val_acc: 0.6
552

Epoch 00173: val_acc did not improve from 0.75862
Epoch 174/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7062 - acc: 0.8631 - val_loss: 3.5186 - val_acc: 0.6
552

Epoch 00174: val_acc did not improve from 0.75862
Epoch 175/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0450 - acc: 0.8264 - val_loss: 0.9963 - val_acc: 0.6
552

Epoch 00175: val_acc did not improve from 0.75862
Epoch 176/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 0.7468 - acc: 0.8328 - val_loss: 2.0729 - val_acc: 0.7
069

Epoch 00176: val_acc did not improve from 0.75862
Epoch 177/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7726 - acc: 0.8408 - val_loss: 1.0135 - val_acc: 0.6
379

Epoch 00177: val_acc did not improve from 0.75862
Epoch 178/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9748 - acc: 0.8360 - val_loss: 1.5285 - val_acc: 0.6
379

Epoch 00178: val_acc did not improve from 0.75862
Epoch 179/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9344 - acc: 0.7803 - val_loss: 1.6243 - val_acc: 0.6
724

Epoch 00179: val_acc did not improve from 0.75862
Epoch 180/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8022 - acc: 0.8567 - val_loss: 1.7623 - val_acc: 0.6
034

Epoch 00180: val_acc did not improve from 0.75862
Epoch 181/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7009 - acc: 0.8742 - val_loss: 1.7521 - val_acc: 0.6
552

Epoch 00181: val_acc did not improve from 0.75862
Epoch 182/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7427 - acc: 0.8455 - val_loss: 1.4287 - val_acc: 0.6
724

Epoch 00182: val_acc did not improve from 0.75862
Epoch 183/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8061 - acc: 0.8376 - val_loss: 1.2563 - val_acc: 0.6
207

Epoch 00183: val_acc did not improve from 0.75862
Epoch 184/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6405 - acc: 0.8439 - val_loss: 2.8008 - val_acc: 0.6
379
```

```
Epoch 00184: val_acc did not improve from 0.75862
Epoch 185/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9372 - acc: 0.8201 - val_loss: 2.2936 - val_acc: 0.7
069

Epoch 00185: val_acc did not improve from 0.75862
Epoch 186/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6831 - acc: 0.8694 - val_loss: 1.0099 - val_acc: 0.6
897

Epoch 00186: val_acc did not improve from 0.75862
Epoch 187/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7347 - acc: 0.8344 - val_loss: 3.0252 - val_acc: 0.6
552

Epoch 00187: val_acc did not improve from 0.75862
Epoch 188/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8728 - acc: 0.8503 - val_loss: 1.5564 - val_acc: 0.6
724

Epoch 00188: val_acc did not improve from 0.75862
Epoch 189/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6308 - acc: 0.8694 - val_loss: 2.7283 - val_acc: 0.6
379

Epoch 00189: val_acc did not improve from 0.75862
Epoch 190/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8310 - acc: 0.8439 - val_loss: 1.8246 - val_acc: 0.6
034

Epoch 00190: val_acc did not improve from 0.75862
Epoch 191/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8898 - acc: 0.8264 - val_loss: 2.6987 - val_acc: 0.4
828

Epoch 00191: val_acc did not improve from 0.75862
Epoch 192/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8924 - acc: 0.8408 - val_loss: 1.3436 - val_acc: 0.6
207

Epoch 00192: val_acc did not improve from 0.75862
```

```
Epoch 193/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7200 - acc: 0.8312 - val_loss: 2.5907 - val_acc: 0.6
552

Epoch 00193: val_acc did not improve from 0.75862
Epoch 194/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8298 - acc: 0.8408 - val_loss: 1.1995 - val_acc: 0.6
207

Epoch 00194: val_acc did not improve from 0.75862
Epoch 195/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9068 - acc: 0.8455 - val_loss: 1.3944 - val_acc: 0.6
379

Epoch 00195: val_acc did not improve from 0.75862
Epoch 196/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8206 - acc: 0.8631 - val_loss: 1.6900 - val_acc: 0.6
379

Epoch 00196: val_acc did not improve from 0.75862
Epoch 197/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9046 - acc: 0.8185 - val_loss: 1.7053 - val_acc: 0.7
759

Epoch 00197: val_acc improved from 0.75862 to 0.77586, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Original/model_11.h5
Epoch 198/250
157/157 [==============================] - 2s 10ms/step - loss: 0.9657 - acc: 0.8392 - val_loss: 1.2647 - val_acc: 0.
6897

Epoch 00198: val_acc did not improve from 0.77586
Epoch 199/250
157/157 [==============================] - 2s 10ms/step - loss: 0.9471 - acc: 0.8471 - val_loss: 1.5616 - val_acc: 0.
7069

Epoch 00199: val_acc did not improve from 0.77586
Epoch 200/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9098 - acc: 0.8647 - val_loss: 1.0470 - val_acc: 0.6
897

Epoch 00200: val_acc did not improve from 0.77586
Epoch 201/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 0.9179 - acc: 0.8535 - val_loss: 2.2773 - val_acc: 0.5
000

Epoch 00201: val_acc did not improve from 0.77586
Epoch 202/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7794 - acc: 0.8535 - val_loss: 3.8063 - val_acc: 0.5
690

Epoch 00202: val_acc did not improve from 0.77586
Epoch 203/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8384 - acc: 0.8599 - val_loss: 2.1521 - val_acc: 0.7
241

Epoch 00203: val_acc did not improve from 0.77586
Epoch 204/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7886 - acc: 0.8503 - val_loss: 1.8662 - val_acc: 0.6
897

Epoch 00204: val_acc did not improve from 0.77586
Epoch 205/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7579 - acc: 0.8392 - val_loss: 1.3274 - val_acc: 0.6
724

Epoch 00205: val_acc did not improve from 0.77586
Epoch 206/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7469 - acc: 0.8535 - val_loss: 2.4207 - val_acc: 0.6
207

Epoch 00206: val_acc did not improve from 0.77586
Epoch 207/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8343 - acc: 0.8392 - val_loss: 1.2732 - val_acc: 0.5
172

Epoch 00207: val_acc did not improve from 0.77586
Epoch 208/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8556 - acc: 0.8408 - val_loss: 2.7589 - val_acc: 0.6
724

Epoch 00208: val_acc did not improve from 0.77586
Epoch 209/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9895 - acc: 0.8567 - val_loss: 1.5328 - val_acc: 0.7
241
```

```
Epoch 00209: val_acc did not improve from 0.77586
Epoch 210/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8538 - acc: 0.8599 - val_loss: 2.4040 - val_acc: 0.7
414

Epoch 00210: val_acc did not improve from 0.77586
Epoch 211/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0053 - acc: 0.8487 - val_loss: 1.7513 - val_acc: 0.7
241

Epoch 00211: val_acc did not improve from 0.77586
Epoch 212/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0729 - acc: 0.7994 - val_loss: 1.7921 - val_acc: 0.7
414

Epoch 00212: val_acc did not improve from 0.77586
Epoch 213/250
157/157 [==============================] - 2s 10ms/step - loss: 0.7283 - acc: 0.8599 - val_loss: 1.5851 - val_acc: 0.
6724

Epoch 00213: val_acc did not improve from 0.77586
Epoch 214/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8055 - acc: 0.8408 - val_loss: 1.9934 - val_acc: 0.7
241

Epoch 00214: val_acc did not improve from 0.77586
Epoch 215/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7689 - acc: 0.8312 - val_loss: 1.8431 - val_acc: 0.6
034

Epoch 00215: val_acc did not improve from 0.77586
Epoch 216/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9578 - acc: 0.8264 - val_loss: 1.9993 - val_acc: 0.7
414

Epoch 00216: val_acc did not improve from 0.77586
Epoch 217/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9176 - acc: 0.8233 - val_loss: 1.2552 - val_acc: 0.5
862

Epoch 00217: val_acc did not improve from 0.77586
```

```
Epoch 218/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7310 - acc: 0.8678 - val_loss: 1.3872 - val_acc: 0.6
897

Epoch 00218: val_acc did not improve from 0.77586
Epoch 219/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8074 - acc: 0.8232 - val_loss: 2.3758 - val_acc: 0.6
897

Epoch 00219: val_acc did not improve from 0.77586
Epoch 220/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4925 - acc: 0.8233 - val_loss: 1.6582 - val_acc: 0.5
862

Epoch 00220: val_acc did not improve from 0.77586
Epoch 221/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8404 - acc: 0.8646 - val_loss: 1.4904 - val_acc: 0.7
069

Epoch 00221: val_acc did not improve from 0.77586
Epoch 222/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6737 - acc: 0.8567 - val_loss: 1.8841 - val_acc: 0.7
069

Epoch 00222: val_acc did not improve from 0.77586
Epoch 223/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8551 - acc: 0.8392 - val_loss: 1.6652 - val_acc: 0.7
241

Epoch 00223: val_acc did not improve from 0.77586
Epoch 224/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6961 - acc: 0.8519 - val_loss: 0.9361 - val_acc: 0.7
069

Epoch 00224: val_acc did not improve from 0.77586
Epoch 225/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0477 - acc: 0.8185 - val_loss: 2.9283 - val_acc: 0.6
897

Epoch 00225: val_acc did not improve from 0.77586
Epoch 226/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0065 - acc: 0.8248 - val_loss: 2.1869 - val_acc: 0.6
```

552

```
Epoch 00226: val_acc did not improve from 0.77586
Epoch 227/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9081 - acc: 0.8408 - val_loss: 2.5123 - val_acc: 0.7
069

Epoch 00227: val_acc did not improve from 0.77586
Epoch 228/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0576 - acc: 0.8280 - val_loss: 1.6235 - val_acc: 0.6
379

Epoch 00228: val_acc did not improve from 0.77586
Epoch 229/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7544 - acc: 0.8631 - val_loss: 1.5058 - val_acc: 0.7
069

Epoch 00229: val_acc did not improve from 0.77586
Epoch 230/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0083 - acc: 0.8264 - val_loss: 1.2757 - val_acc: 0.7
241

Epoch 00230: val_acc did not improve from 0.77586
Epoch 231/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8831 - acc: 0.8551 - val_loss: 1.0566 - val_acc: 0.7
414

Epoch 00231: val_acc did not improve from 0.77586
Epoch 232/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8817 - acc: 0.8296 - val_loss: 1.0716 - val_acc: 0.6
897

Epoch 00232: val_acc did not improve from 0.77586
Epoch 233/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7395 - acc: 0.8615 - val_loss: 1.3925 - val_acc: 0.7
069

Epoch 00233: val_acc did not improve from 0.77586
Epoch 234/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8630 - acc: 0.8487 - val_loss: 1.5261 - val_acc: 0.6
724
```

```
Epoch 00234: val_acc did not improve from 0.77586
Epoch 235/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8944 - acc: 0.8137 - val_loss: 2.4661 - val_acc: 0.5
345

Epoch 00235: val_acc did not improve from 0.77586
Epoch 236/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9007 - acc: 0.8233 - val_loss: 1.0435 - val_acc: 0.6
034

Epoch 00236: val_acc did not improve from 0.77586
Epoch 237/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8098 - acc: 0.8487 - val_loss: 1.1825 - val_acc: 0.6
724

Epoch 00237: val_acc did not improve from 0.77586
Epoch 238/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8081 - acc: 0.8328 - val_loss: 1.5083 - val_acc: 0.6
724

Epoch 00238: val_acc did not improve from 0.77586
Epoch 239/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8289 - acc: 0.8424 - val_loss: 1.9747 - val_acc: 0.6
724

Epoch 00239: val_acc did not improve from 0.77586
Epoch 240/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1720 - acc: 0.8296 - val_loss: 2.0374 - val_acc: 0.6
207

Epoch 00240: val_acc did not improve from 0.77586
Epoch 241/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0054 - acc: 0.7882 - val_loss: 1.2899 - val_acc: 0.5
345

Epoch 00241: val_acc did not improve from 0.77586
Epoch 242/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6689 - acc: 0.8376 - val_loss: 1.3590 - val_acc: 0.6
379

Epoch 00242: val_acc did not improve from 0.77586
Epoch 243/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 1.1484 - acc: 0.8057 - val_loss: 1.3405 - val_acc: 0.6
207

Epoch 00243: val_acc did not improve from 0.77586
Epoch 244/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0732 - acc: 0.8121 - val_loss: 1.7858 - val_acc: 0.6
724

Epoch 00244: val_acc did not improve from 0.77586
Epoch 245/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7762 - acc: 0.8376 - val_loss: 2.0496 - val_acc: 0.7
069

Epoch 00245: val_acc did not improve from 0.77586
Epoch 246/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9161 - acc: 0.8232 - val_loss: 1.2938 - val_acc: 0.5
345

Epoch 00246: val_acc did not improve from 0.77586
Epoch 247/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8418 - acc: 0.8424 - val_loss: 1.4373 - val_acc: 0.6
552

Epoch 00247: val_acc did not improve from 0.77586
Epoch 248/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9166 - acc: 0.8137 - val_loss: 1.1904 - val_acc: 0.6
379

Epoch 00248: val_acc did not improve from 0.77586
Epoch 249/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9842 - acc: 0.8376 - val_loss: 1.5307 - val_acc: 0.6
552

Epoch 00249: val_acc did not improve from 0.77586
Epoch 250/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9545 - acc: 0.8041 - val_loss: 1.2646 - val_acc: 0.6
034

Epoch 00250: val_acc did not improve from 0.77586
```

```
In [14]:  sns.set()
          plt.plot(history.history['acc'], 'r')
          plt.plot(history.history['val_acc'], 'b')
          plt.legend({'Train Accuracy': 'r', 'Test Accuracy':'b'})
          plt.show()
          plt.plot(history.history['loss'], 'r')
          plt.plot(history.history['val_loss'], 'b')
          plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
          plt.show()
```
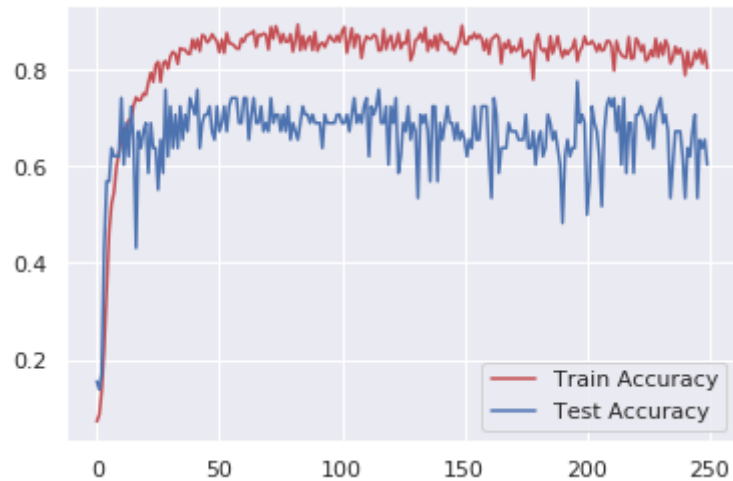
```
In [0]: model.load_weights(path+'Results/Results-Original/model_11.h5')
```

```
In [16]: y_pred_tr = model.predict(X_train)

y_tr2 = y_train.argmax(1)
y_pred_tr = y_pred_tr.argmax(1)

train_acc = accuracy_score(y_tr2, y_pred_tr)
print("Train Accuracy : ", train_acc)
```

```
Train Accuracy :  0.9650793650793651
```
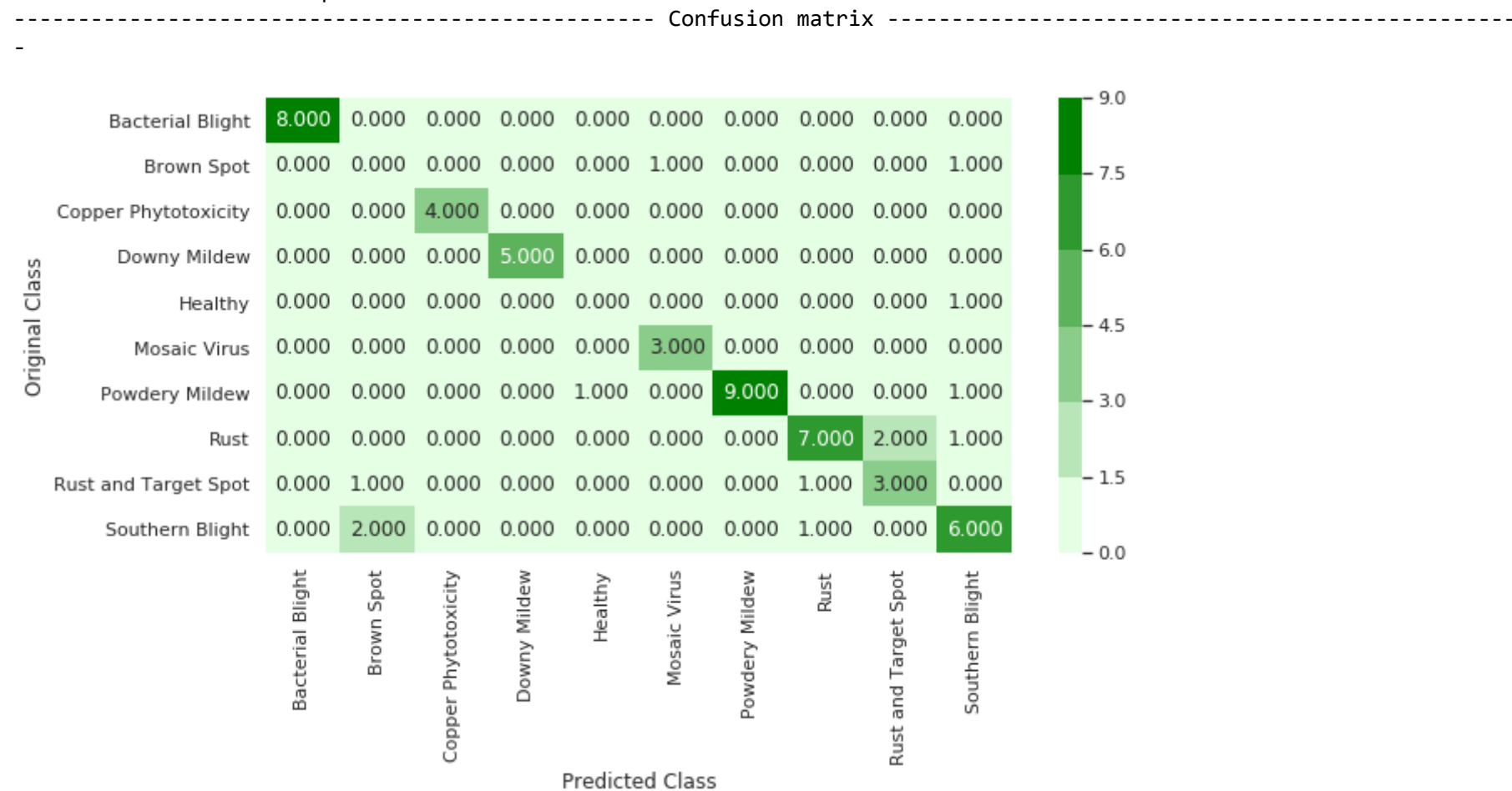
```
In [17]: y_pred = model.predict(X_test)

y_te2 = y_test.argmax(1)
y_pred = y_pred.argmax(1)

test_acc = accuracy_score(y_te2, y_pred)
print("Test Accuracy : ", test_acc)
```

```
Test Accuracy :  0.7758620689655172
```

In [20]: `plot_confusion_matrix(test_y=y_te2, predict_y=y_pred, labels=folders)`
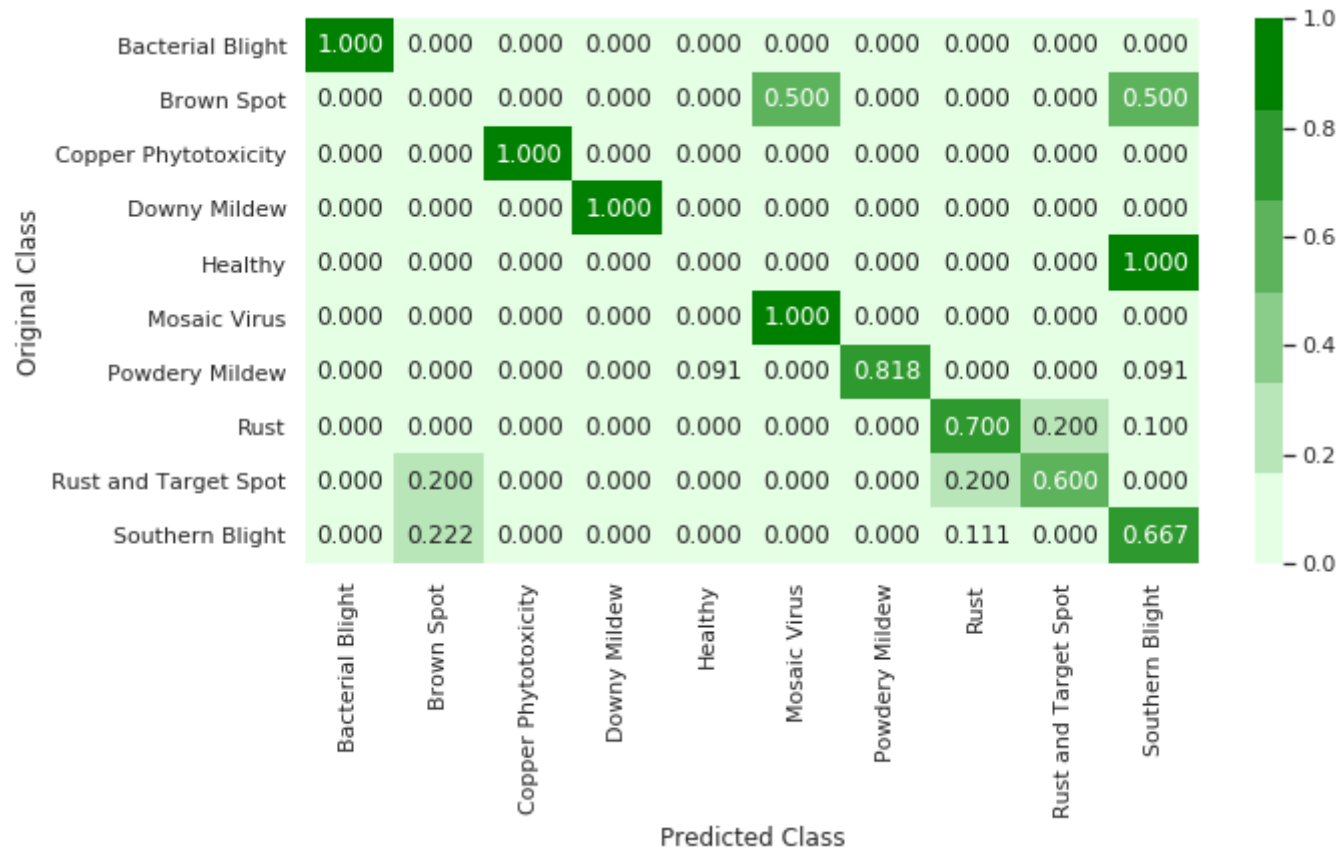
Number of misclassified points 22.413793103448278

-- Confusion matrix --
-

-- Precision matrix --
-

```
Sum of columns in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]
-------------------------------------------------- Recall matrix --------------------------------------------------
```

Sum of rows in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

4.2 Classification Model on Cropped Leaf Images

4.2.1 Preparing Data

```
In [0]: path = '/content/drive/My Drive/Leaf Disease Classification/'
        dataset='/content/drive/My Drive/Leaf Disease Classification/Soyabean-Cropped/'
        folders = os.listdir(dataset)
        folders.sort()
```

In [0]:
```python
# Renaming image names as per our convenience
idx = 1
for folder in folders:
    imgs = os.listdir(dataset+folder+os.sep)
    imgs.sort()

    for img in imgs:
        src_name = dataset+folder+os.sep+img
        im_name = 'IMG_CROP_'+format(idx, '04d')+'.jpg'
        dst_name = dataset+folder+os.sep+im_name
        os.rename(src_name, dst_name)

        img_names.append(im_name)
        labels.append(folder)
        idx = idx+1
```

In [0]:
```python
# Storing image data in csv file
img_names = []
img_array = []
labels = []

for folder in folders:
    imgs = os.listdir(dataset+folder+os.sep)
    imgs.sort()

    for img in imgs:
        im = cv2.imread(dataset+folder+os.sep+img)
        im_rgb = cv2.cvtColor(im, cv2.COLOR_BGR2RGB)
        im_size = cv2.resize(im_rgb, (144, 144), interpolation=cv2.INTER_AREA)

        img_names.append(img)
        img_array.append(im_size)
        labels.append(folder)

df = pd.DataFrame({'Image ID': img_names, 'Class': labels})
df.to_csv(path+'Files-Cropped/soyabean_cropped.csv', index=False)

# Saving image data in numpy array format
X = np.asarray(img_array)
np.save(path+'Files-Cropped/imgs_original', X)
```

In [0]:
```python
data = pd.read_csv(path+'Files-Cropped/soyabean_cropped.csv')
data.head()
```

Out[0]:

	Image ID	Class
0	IMG_CROP_0001.jpg	Bacterial Blight
1	IMG_CROP_0002.jpg	Bacterial Blight
2	IMG_CROP_0003.jpg	Bacterial Blight
3	IMG_CROP_0004.jpg	Bacterial Blight
4	IMG_CROP_0005.jpg	Bacterial Blight

In [0]:
```python
data['Class'].value_counts()
```

Out[0]:
```
Powdery Mildew          74
Rust                    64
Southern Blight         62
Bacterial Blight        51
Downy Mildew            33
Rust and Target Spot    32
Copper Phytotoxicity    23
Mosaic Virus            22
Brown Spot              13
Healthy                  9
Name: Class, dtype: int64
```

In [0]:
```python
# Mapping original class labels to integer values
folders = os.listdir(dataset)
folders.sort()

labels = {}
val_cnt = 0
for folder in folders:
    labels[folder] = val_cnt
    val_cnt = val_cnt+1

labels
```

Out[0]: {'Bacterial Blight': 0,
 'Brown Spot': 1,
 'Copper Phytotoxicity': 2,
 'Downy Mildew': 3,
 'Healthy': 4,
 'Mosaic Virus': 5,
 'Powdery Mildew': 6,
 'Rust': 7,
 'Rust and Target Spot': 8,
 'Southern Blight': 9}

In [0]:
```python
X = np.load(path+'Files-Cropped/imgs_original.npy')
y = data['Class'].map(labels).values

data['Image Array'] = X.tolist()
data['Labels'] = y

data.head()
```

Out[0]:

	Image ID	Class	Image Array	Labels
0	IMG_CROP_0001.jpg	Bacterial Blight	[[[132, 97, 77], [134, 98, 85], [135, 99, 86],...	0
1	IMG_CROP_0002.jpg	Bacterial Blight	[[[196, 150, 135], [194, 151, 134], [198, 151,...	0
2	IMG_CROP_0003.jpg	Bacterial Blight	[[[148, 111, 100], [127, 104, 97], [88, 78, 88...	0
3	IMG_CROP_0004.jpg	Bacterial Blight	[[[136, 130, 134], [134, 128, 133], [126, 122,...	0
4	IMG_CROP_0005.jpg	Bacterial Blight	[[[110, 96, 88], [114, 95, 93], [122, 98, 99],...	0

In [0]:
```python
X = data.drop(['Image ID', 'Class', 'Labels'], axis=1)
y = data['Labels']

X_tr, X_te, y_tr, y_te = train_test_split(X, y, test_size=0.15, stratify=y, random_state=0)
```

In [0]:
```python
imbalance_train = X_tr.copy()
imbalance_train['Labels'] = y_tr
imbalance_train['Labels'].value_counts()
```

Out[0]:
```
6    63
7    54
9    53
0    43
3    28
8    27
5    19
2    19
1    11
4     8
Name: Labels, dtype: int64
```

In [0]:
```python
# Reference: upsampling in python-https://elitedatascience.com/imbalanced-classes

# Separate majority and minority classes
majority_class = imbalance_train[imbalance_train.Labels == 6]

# Upsampling for imbalance dataset in python
upsampled_classes = [majority_class]
minority_labels = [0,1,2,3,4,5,7,8,9]

for i in minority_labels:
    minority_class = imbalance_train[imbalance_train.Labels == i]
    minority_upsampled = resample(minority_class,
                                  replace = True,
                                  n_samples = majority_class.shape[0],
                                  random_state = 0)
    upsampled_classes.append(minority_upsampled)

train_upsampled = pd.concat(upsampled_classes)
print(train_upsampled['Labels'].value_counts())
```

```
9    63
8    63
7    63
6    63
5    63
4    63
3    63
2    63
1    63
0    63
Name: Labels, dtype: int64
```

In [0]: `train_upsampled.head()`

Out[0]:

	Image Array	Labels
215	[[[124, 120, 122], [133, 126, 128], [130, 125,...	6
174	[[[94, 82, 88], [95, 84, 91], [98, 82, 92], [9...	6
200	[[[238, 237, 237], [239, 236, 235], [186, 181,...	6
203	[[[127, 124, 127], [130, 126, 129], [130, 124,...	6
162	[[[74, 69, 73], [72, 71, 68], [68, 69, 64], [6...	6

In [0]:
```
train_shuffled = train_upsampled.sample(frac=1, random_state=0)
train_shuffled.head()
```

Out[0]:

	Image Array	Labels
145	[[[63, 60, 75], [216, 210, 209], [222, 214, 21...	5
141	[[[30, 30, 24], [29, 30, 24], [27, 30, 27], [2...	5
91	[[[177, 166, 167], [174, 167, 165], [115, 108,...	3
84	[[[54, 48, 52], [48, 46, 45], [50, 48, 46], [5...	2
233	[[[62, 60, 56], [73, 69, 76], [181, 176, 176],...	7

In [0]:
```
X_tr1 = train_shuffled['Image Array'].values
y_tr1 = train_shuffled['Labels'].values
```

4.2.2 CNN Models

In [0]:
```
y_train = keras.utils.to_categorical(y_tr1, num_classes=10)
y_test = keras.utils.to_categorical(y_te, num_classes=10)
```

```
In [0]: train_X = X_tr1.tolist()
        X_train = np.asarray(train_X)

        X_te1 = X_te['Image Array'].values
        test_X = X_te1.tolist()
        X_test = np.asarray(test_X)
```

```
In [0]: np.save(path+'Files-Cropped/X_train_orig', X_train)
        np.save(path+'Files-Cropped/X_test_orig', X_test)

        np.save(path+'Files-Cropped/y_train_orig', y_train)
        np.save(path+'Files-Cropped/y_test_orig', y_test)
```

```
In [0]: path = '/content/drive/My Drive/Leaf Disease Classification/'
        X_train = np.load(path+'Files-Cropped/X_train_orig.npy')
        X_test = np.load(path+'Files-Cropped/X_test_orig.npy')
```

```
In [0]: y_train = np.load(path+'Files-Cropped/y_train_orig.npy')
        y_test = np.load(path+'Files-Cropped/y_test_orig.npy')
```

```
In [18]: print(X_train.shape, X_test.shape)
```

```
(630, 144, 144, 3) (58, 144, 144, 3)
```

```
In [0]: # Scaling pixel values - Normalization
        X_train = X_train.astype('float32')
        X_test = X_test.astype('float32')

        X_train = X_train/255
        X_test = X_test/255
```

```
In [0]: # Model parameters
        input_shape = (144, 144, 3)
        num_classes = 10
```

In [0]:
```python
# Performing Data Augmentation on training data
datagen = ImageDataGenerator(horizontal_flip=True,
                             vertical_flip=True)
datagen.fit(X_train)
it_train = datagen.flow(X_train, y_train, batch_size=4)
steps = int(X_train.shape[0]/4)
```

Model 1

In [0]:
```python
# Saving model weights and other important parameters
checkpoint = ModelCheckpoint(path+"Results/Results-Cropped/model_2.h5", monitor="val_acc",
                             mode="max", save_best_only=True, verbose=1)
tensorboard = TensorBoard(log_dir=path+'Results/Results-Cropped/graph_2', histogram_freq=4, batch_size=4,
                          update_freq='epoch')

callbacks = [checkpoint, tensorboard]
```

In [21]:
```python
model2 = Sequential()
model2.add(Conv2D(32, (3, 3), activation='relu', padding='same', strides=(2, 2),
                  kernel_initializer='he_normal', input_shape=input_shape))
model2.add(Conv2D(64, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(BatchNormalization())
model2.add(Dropout(0.2))

model2.add(Conv2D(128, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model2.add(Conv2D(128, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model2.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(BatchNormalization())
model2.add(Dropout(0.3))

model2.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model2.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(BatchNormalization())
model2.add(Dropout(0.3))
model2.add(Flatten())

model2.add(Dense(512, activation='relu', kernel_initializer='he_normal'))
model2.add(Dropout(0.5))
model2.add(Dense(128, activation='relu', kernel_initializer='he_normal'))
model2.add(Dropout(0.5))
model2.add(Dense(64, activation='relu', kernel_initializer='he_normal'))

model2.add(Dense(num_classes, activation='softmax'))

model2.compile(loss='categorical_crossentropy', optimizer='rmsprop', metrics=['accuracy'])
model2.summary()
```

```
Model: "sequential_2"
```

Layer (type)	Output Shape	Param #
conv2d_8 (Conv2D)	(None, 72, 72, 32)	896
conv2d_9 (Conv2D)	(None, 72, 72, 64)	18496
max_pooling2d_4 (MaxPooling2	(None, 36, 36, 64)	0
batch_normalization_4 (Batch	(None, 36, 36, 64)	256
dropout_6 (Dropout)	(None, 36, 36, 64)	0
conv2d_10 (Conv2D)	(None, 36, 36, 128)	73856
conv2d_11 (Conv2D)	(None, 36, 36, 128)	147584
conv2d_12 (Conv2D)	(None, 36, 36, 256)	295168
max_pooling2d_5 (MaxPooling2	(None, 18, 18, 256)	0
batch_normalization_5 (Batch	(None, 18, 18, 256)	1024
dropout_7 (Dropout)	(None, 18, 18, 256)	0
conv2d_13 (Conv2D)	(None, 18, 18, 256)	590080
conv2d_14 (Conv2D)	(None, 18, 18, 256)	590080
max_pooling2d_6 (MaxPooling2	(None, 9, 9, 256)	0
batch_normalization_6 (Batch	(None, 9, 9, 256)	1024
dropout_8 (Dropout)	(None, 9, 9, 256)	0
flatten_2 (Flatten)	(None, 20736)	0
dense_5 (Dense)	(None, 512)	10617344
dropout_9 (Dropout)	(None, 512)	0

dense_6 (Dense)	(None, 128)	65664
dropout_10 (Dropout)	(None, 128)	0
dense_7 (Dense)	(None, 64)	8256
dense_8 (Dense)	(None, 10)	650

```
=================================================================
Total params: 12,410,378
Trainable params: 12,409,226
Non-trainable params: 1,152
```

```
In [0]: history = model2.fit_generator(it_train, steps_per_epoch=steps,
                                        epochs=300, validation_data=(X_test, y_test),
                                        verbose=1, callbacks=callbacks)
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (f
rom tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.
assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.
assign is deprecated. Please use tf.compat.v1.assign instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1068: The name tf.summary.histogram
is deprecated. Please use tf.compat.v1.summary.histogram instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122: The name tf.summary.merge_all
is deprecated. Please use tf.compat.v1.summary.merge_all instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125: The name tf.summary.FileWrite
r is deprecated. Please use tf.compat.v1.summary.FileWriter instead.

Epoch 1/300
157/157 [==============================] - 5s 35ms/step - loss: 13.0292 - acc: 0.1147 - val_loss: 15.1363 - val_acc:
0.0345

Epoch 00001: val_acc improved from -inf to 0.03448, saving model to /content/drive/My Drive/Leaf Disease Classificati
on/Results/Results-Cropped/model_2.h5
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265: The name tf.Summary is deprec
ated. Please use tf.compat.v1.Summary instead.

Epoch 2/300
157/157 [==============================] - 3s 18ms/step - loss: 13.0802 - acc: 0.1561 - val_loss: 15.1412 - val_acc:
0.0517

Epoch 00002: val_acc improved from 0.03448 to 0.05172, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_2.h5
Epoch 3/300
157/157 [==============================] - 3s 18ms/step - loss: 13.4122 - acc: 0.1449 - val_loss: 13.1482 - val_acc:
0.1724

Epoch 00003: val_acc improved from 0.05172 to 0.17241, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_2.h5
Epoch 4/300

157/157 [==============================] - 3s 18ms/step - loss: 13.0691 - acc: 0.1704 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00004: val_acc did not improve from 0.17241
Epoch 5/300
157/157 [==============================] - 3s 18ms/step - loss: 13.4501 - acc: 0.1433 - val_loss: 14.3615 - val_acc: 0.0690

Epoch 00005: val_acc did not improve from 0.17241
Epoch 6/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5260 - acc: 0.1338 - val_loss: 11.4305 - val_acc: 0.2586

Epoch 00006: val_acc improved from 0.17241 to 0.25862, saving model to /content/drive/My Drive/Leaf Disease Classification/Results/Results-Cropped/model_2.h5
Epoch 7/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2670 - acc: 0.1433 - val_loss: 12.3603 - val_acc: 0.1897

Epoch 00007: val_acc did not improve from 0.25862
Epoch 8/300
157/157 [==============================] - 3s 18ms/step - loss: 13.7569 - acc: 0.1258 - val_loss: 13.8715 - val_acc: 0.1034

Epoch 00008: val_acc did not improve from 0.25862
Epoch 9/300
157/157 [==============================] - 3s 19ms/step - loss: 13.5121 - acc: 0.1322 - val_loss: 14.4507 - val_acc: 0.1034

Epoch 00009: val_acc did not improve from 0.25862
Epoch 10/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5838 - acc: 0.1369 - val_loss: 15.1090 - val_acc: 0.0517

Epoch 00010: val_acc did not improve from 0.25862
Epoch 11/300
157/157 [==============================] - 3s 18ms/step - loss: 13.2310 - acc: 0.1688 - val_loss: 13.8624 - val_acc: 0.1379

Epoch 00011: val_acc did not improve from 0.25862
Epoch 12/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8426 - acc: 0.1815 - val_loss: 12.8722 - val_acc:

```
0.1897

Epoch 00012: val_acc did not improve from 0.25862
Epoch 13/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1489 - acc: 0.1672 - val_loss: 13.0612 - val_acc:
0.1897

Epoch 00013: val_acc did not improve from 0.25862
Epoch 14/300
157/157 [==============================] - 3s 18ms/step - loss: 12.7759 - acc: 0.1927 - val_loss: 11.9496 - val_acc:
0.2586

Epoch 00014: val_acc did not improve from 0.25862
Epoch 15/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7182 - acc: 0.1990 - val_loss: 12.6331 - val_acc:
0.2069

Epoch 00015: val_acc did not improve from 0.25862
Epoch 16/300
157/157 [==============================] - 3s 17ms/step - loss: 12.4416 - acc: 0.2118 - val_loss: 15.2844 - val_acc:
0.0517

Epoch 00016: val_acc did not improve from 0.25862
Epoch 17/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8555 - acc: 0.1943 - val_loss: 13.2766 - val_acc:
0.1724

Epoch 00017: val_acc did not improve from 0.25862
Epoch 18/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1251 - acc: 0.1752 - val_loss: 15.2844 - val_acc:
0.0517

Epoch 00018: val_acc did not improve from 0.25862
Epoch 19/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4818 - acc: 0.1561 - val_loss: 12.2275 - val_acc:
0.2414

Epoch 00019: val_acc did not improve from 0.25862
Epoch 20/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4651 - acc: 0.1561 - val_loss: 12.3977 - val_acc:
0.1897
```

```
        Epoch 00020: val_acc did not improve from 0.25862
        Epoch 21/300
        157/157 [==============================] - 3s 18ms/step - loss: 12.6195 - acc: 0.1990 - val_loss: 13.5247 - val_acc:
        0.1552


        Epoch 00021: val_acc did not improve from 0.25862
        Epoch 22/300
        157/157 [==============================] - 3s 17ms/step - loss: 12.7468 - acc: 0.1847 - val_loss: 12.2275 - val_acc:
        0.2414


        Epoch 00022: val_acc did not improve from 0.25862
        Epoch 23/300
        157/157 [==============================] - 3s 18ms/step - loss: 12.4594 - acc: 0.2086 - val_loss: 13.0450 - val_acc:
        0.1897


        Epoch 00023: val_acc did not improve from 0.25862
        Epoch 24/300
        157/157 [==============================] - 3s 17ms/step - loss: 12.2356 - acc: 0.2213 - val_loss: 10.9922 - val_acc:
        0.2759


        Epoch 00024: val_acc improved from 0.25862 to 0.27586, saving model to /content/drive/My Drive/Leaf Disease Classific
        ation/Results/Results-Cropped/model_2.h5
        Epoch 25/300
        157/157 [==============================] - 3s 17ms/step - loss: 12.2770 - acc: 0.2118 - val_loss: 13.8949 - val_acc:
        0.1379


        Epoch 00025: val_acc did not improve from 0.27586
        Epoch 26/300
        157/157 [==============================] - 3s 17ms/step - loss: 12.3392 - acc: 0.2197 - val_loss: 11.4897 - val_acc:
        0.2759


        Epoch 00026: val_acc did not improve from 0.27586
        Epoch 27/300
        157/157 [==============================] - 3s 17ms/step - loss: 12.2030 - acc: 0.2309 - val_loss: 10.1018 - val_acc:
        0.3621


        Epoch 00027: val_acc improved from 0.27586 to 0.36207, saving model to /content/drive/My Drive/Leaf Disease Classific
        ation/Results/Results-Cropped/model_2.h5
        Epoch 28/300
        157/157 [==============================] - 3s 17ms/step - loss: 12.4778 - acc: 0.2198 - val_loss: 12.2275 - val_acc:
        0.2414
```

```
Epoch 00028: val_acc did not improve from 0.36207
Epoch 29/300
157/157 [==============================] - 3s 17ms/step - loss: 12.4195 - acc: 0.2134 - val_loss: 11.6790 - val_acc:
0.2414


Epoch 00029: val_acc did not improve from 0.36207
Epoch 30/300
157/157 [==============================] - 3s 17ms/step - loss: 12.4489 - acc: 0.2134 - val_loss: 12.2275 - val_acc:
0.2414


Epoch 00030: val_acc did not improve from 0.36207
Epoch 31/300
157/157 [==============================] - 3s 17ms/step - loss: 12.0487 - acc: 0.2404 - val_loss: 13.3915 - val_acc:
0.1552


Epoch 00031: val_acc did not improve from 0.36207
Epoch 32/300
157/157 [==============================] - 3s 17ms/step - loss: 12.0370 - acc: 0.2357 - val_loss: 13.2738 - val_acc:
0.1379


Epoch 00032: val_acc did not improve from 0.36207
Epoch 33/300
157/157 [==============================] - 3s 17ms/step - loss: 11.8460 - acc: 0.2484 - val_loss: 13.0230 - val_acc:
0.1897


Epoch 00033: val_acc did not improve from 0.36207
Epoch 34/300
157/157 [==============================] - 3s 17ms/step - loss: 11.6806 - acc: 0.2596 - val_loss: 14.4507 - val_acc:
0.1034


Epoch 00034: val_acc did not improve from 0.36207
Epoch 35/300
157/157 [==============================] - 3s 18ms/step - loss: 11.7449 - acc: 0.2532 - val_loss: 13.2536 - val_acc:
0.1724


Epoch 00035: val_acc did not improve from 0.36207
Epoch 36/300
157/157 [==============================] - 3s 17ms/step - loss: 12.3825 - acc: 0.2134 - val_loss: 12.6455 - val_acc:
0.1897


Epoch 00036: val_acc did not improve from 0.36207
Epoch 37/300
```

```
157/157 [==============================] - 3s 17ms/step - loss: 11.8300 - acc: 0.2404 - val_loss: 11.5509 - val_acc:
0.2759

Epoch 00037: val_acc did not improve from 0.36207
Epoch 38/300
157/157 [==============================] - 3s 17ms/step - loss: 12.0024 - acc: 0.2341 - val_loss: 15.2844 - val_acc:
0.0517

Epoch 00038: val_acc did not improve from 0.36207
Epoch 39/300
157/157 [==============================] - 3s 17ms/step - loss: 12.3956 - acc: 0.2150 - val_loss: 9.3187 - val_acc:
0.4138

Epoch 00039: val_acc improved from 0.36207 to 0.41379, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_2.h5
Epoch 40/300
157/157 [==============================] - 3s 17ms/step - loss: 11.4339 - acc: 0.2611 - val_loss: 10.0560 - val_acc:
0.3621

Epoch 00040: val_acc did not improve from 0.41379
Epoch 41/300
157/157 [==============================] - 3s 17ms/step - loss: 12.1689 - acc: 0.2181 - val_loss: 9.4583 - val_acc:
0.3966

Epoch 00041: val_acc did not improve from 0.41379
Epoch 42/300
157/157 [==============================] - 3s 17ms/step - loss: 11.3062 - acc: 0.2739 - val_loss: 12.0859 - val_acc:
0.2241

Epoch 00042: val_acc did not improve from 0.41379
Epoch 43/300
157/157 [==============================] - 3s 17ms/step - loss: 11.8072 - acc: 0.2468 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00043: val_acc did not improve from 0.41379
Epoch 44/300
157/157 [==============================] - 3s 17ms/step - loss: 11.1628 - acc: 0.2882 - val_loss: 12.3141 - val_acc:
0.2241

Epoch 00044: val_acc did not improve from 0.41379
Epoch 45/300
157/157 [==============================] - 3s 17ms/step - loss: 11.6918 - acc: 0.2548 - val_loss: 11.1456 - val_acc:
```

0.2931

Epoch 00045: val_acc did not improve from 0.41379
Epoch 46/300
157/157 [==============================] - 3s 18ms/step - loss: 11.5560 - acc: 0.2723 - val_loss: 12.2774 - val_acc: 0.2069

Epoch 00046: val_acc did not improve from 0.41379
Epoch 47/300
157/157 [==============================] - 3s 17ms/step - loss: 11.0533 - acc: 0.2946 - val_loss: 13.6556 - val_acc: 0.1379

Epoch 00047: val_acc did not improve from 0.41379
Epoch 48/300
157/157 [==============================] - 3s 17ms/step - loss: 11.5443 - acc: 0.2739 - val_loss: 13.0612 - val_acc: 0.1897

Epoch 00048: val_acc did not improve from 0.41379
Epoch 49/300
157/157 [==============================] - 3s 17ms/step - loss: 10.9703 - acc: 0.2978 - val_loss: 11.6381 - val_acc: 0.2586

Epoch 00049: val_acc did not improve from 0.41379
Epoch 50/300
157/157 [==============================] - 3s 18ms/step - loss: 11.6650 - acc: 0.2675 - val_loss: 13.0626 - val_acc: 0.1897

Epoch 00050: val_acc did not improve from 0.41379
Epoch 51/300
157/157 [==============================] - 3s 18ms/step - loss: 11.6404 - acc: 0.2675 - val_loss: 10.9929 - val_acc: 0.2931

Epoch 00051: val_acc did not improve from 0.41379
Epoch 52/300
157/157 [==============================] - 3s 17ms/step - loss: 11.9106 - acc: 0.2436 - val_loss: 14.1729 - val_acc: 0.1207

Epoch 00052: val_acc did not improve from 0.41379
Epoch 53/300
157/157 [==============================] - 3s 17ms/step - loss: 12.0711 - acc: 0.2341 - val_loss: 13.0612 - val_acc: 0.1897

```
            Epoch 00053: val_acc did not improve from 0.41379
            Epoch 54/300
            157/157 [==============================] - 3s 17ms/step - loss: 11.6292 - acc: 0.2643 - val_loss: 13.2533 - val_acc:
            0.1724


            Epoch 00054: val_acc did not improve from 0.41379
            Epoch 55/300
            157/157 [==============================] - 3s 17ms/step - loss: 11.4544 - acc: 0.2675 - val_loss: 12.8689 - val_acc:
            0.1724


            Epoch 00055: val_acc did not improve from 0.41379
            Epoch 56/300
            157/157 [==============================] - 3s 17ms/step - loss: 11.6113 - acc: 0.2643 - val_loss: 12.9572 - val_acc:
            0.1897


            Epoch 00056: val_acc did not improve from 0.41379
            Epoch 57/300
            157/157 [==============================] - 3s 17ms/step - loss: 11.2680 - acc: 0.2850 - val_loss: 10.9350 - val_acc:
            0.2931


            Epoch 00057: val_acc did not improve from 0.41379
            Epoch 58/300
            157/157 [==============================] - 3s 17ms/step - loss: 10.7269 - acc: 0.3248 - val_loss: 10.2571 - val_acc:
            0.3448


            Epoch 00058: val_acc did not improve from 0.41379
            Epoch 59/300
            157/157 [==============================] - 3s 17ms/step - loss: 10.8577 - acc: 0.3105 - val_loss: 12.2526 - val_acc:
            0.2241


            Epoch 00059: val_acc did not improve from 0.41379
            Epoch 60/300
            157/157 [==============================] - 3s 17ms/step - loss: 10.7750 - acc: 0.3169 - val_loss: 15.1343 - val_acc:
            0.0517


            Epoch 00060: val_acc did not improve from 0.41379
            Epoch 61/300
            157/157 [==============================] - 3s 17ms/step - loss: 11.2013 - acc: 0.2898 - val_loss: 11.2725 - val_acc:
            0.2759


            Epoch 00061: val_acc did not improve from 0.41379
            Epoch 62/300
```

157/157 [==============================] - 3s 18ms/step - loss: 11.2331 - acc: 0.2866 - val_loss: 12.7858 - val_acc: 0.2069

Epoch 00062: val_acc did not improve from 0.41379
Epoch 63/300
157/157 [==============================] - 3s 18ms/step - loss: 11.5736 - acc: 0.2659 - val_loss: 13.0222 - val_acc: 0.1897

Epoch 00063: val_acc did not improve from 0.41379
Epoch 64/300
157/157 [==============================] - 3s 18ms/step - loss: 12.0256 - acc: 0.2452 - val_loss: 13.6188 - val_acc: 0.1552

Epoch 00064: val_acc did not improve from 0.41379
Epoch 65/300
157/157 [==============================] - 3s 18ms/step - loss: 10.4892 - acc: 0.3328 - val_loss: 11.0926 - val_acc: 0.3103

Epoch 00065: val_acc did not improve from 0.41379
Epoch 66/300
157/157 [==============================] - 3s 18ms/step - loss: 11.1799 - acc: 0.2978 - val_loss: 13.0612 - val_acc: 0.1897

Epoch 00066: val_acc did not improve from 0.41379
Epoch 67/300
157/157 [==============================] - 3s 18ms/step - loss: 10.8890 - acc: 0.3041 - val_loss: 12.3295 - val_acc: 0.2241

Epoch 00067: val_acc did not improve from 0.41379
Epoch 68/300
157/157 [==============================] - 3s 18ms/step - loss: 10.6524 - acc: 0.3248 - val_loss: 13.0612 - val_acc: 0.1897

Epoch 00068: val_acc did not improve from 0.41379
Epoch 69/300
157/157 [==============================] - 3s 18ms/step - loss: 10.6090 - acc: 0.3280 - val_loss: 11.3950 - val_acc: 0.2931

Epoch 00069: val_acc did not improve from 0.41379
Epoch 70/300
157/157 [==============================] - 3s 18ms/step - loss: 10.3523 - acc: 0.3455 - val_loss: 11.5096 - val_acc: 0.2759

```
Epoch 00070: val_acc did not improve from 0.41379
Epoch 71/300
157/157 [==============================] - 3s 18ms/step - loss: 10.6894 - acc: 0.3217 - val_loss: 9.6501 - val_acc:
0.3966

Epoch 00071: val_acc did not improve from 0.41379
Epoch 72/300
157/157 [==============================] - 3s 18ms/step - loss: 10.0161 - acc: 0.3583 - val_loss: 9.9651 - val_acc:
0.3448

Epoch 00072: val_acc did not improve from 0.41379
Epoch 73/300
157/157 [==============================] - 3s 18ms/step - loss: 11.8366 - acc: 0.2532 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00073: val_acc did not improve from 0.41379
Epoch 74/300
157/157 [==============================] - 3s 18ms/step - loss: 11.2093 - acc: 0.2834 - val_loss: 12.5054 - val_acc:
0.2241

Epoch 00074: val_acc did not improve from 0.41379
Epoch 75/300
157/157 [==============================] - 3s 18ms/step - loss: 10.4908 - acc: 0.3296 - val_loss: 12.1373 - val_acc:
0.2414

Epoch 00075: val_acc did not improve from 0.41379
Epoch 76/300
157/157 [==============================] - 3s 18ms/step - loss: 10.9426 - acc: 0.2994 - val_loss: 11.4018 - val_acc:
0.2759

Epoch 00076: val_acc did not improve from 0.41379
Epoch 77/300
157/157 [==============================] - 3s 18ms/step - loss: 10.0132 - acc: 0.3647 - val_loss: 11.5375 - val_acc:
0.2759

Epoch 00077: val_acc did not improve from 0.41379
Epoch 78/300
157/157 [==============================] - 3s 18ms/step - loss: 10.3336 - acc: 0.3408 - val_loss: 12.2275 - val_acc:
0.2414

Epoch 00078: val_acc did not improve from 0.41379
```

```
Epoch 79/300
157/157 [==============================] - 3s 18ms/step - loss: 10.4590 - acc: 0.3344 - val_loss: 10.8692 - val_acc:
0.3103

Epoch 00079: val_acc did not improve from 0.41379
Epoch 80/300
157/157 [==============================] - 3s 17ms/step - loss: 10.9153 - acc: 0.3169 - val_loss: 10.0043 - val_acc:
0.3793

Epoch 00080: val_acc did not improve from 0.41379
Epoch 81/300
157/157 [==============================] - 3s 18ms/step - loss: 11.0052 - acc: 0.3026 - val_loss: 10.9122 - val_acc:
0.3103

Epoch 00081: val_acc did not improve from 0.41379
Epoch 82/300
157/157 [==============================] - 3s 18ms/step - loss: 10.7467 - acc: 0.3232 - val_loss: 8.9584 - val_acc:
0.4138

Epoch 00082: val_acc did not improve from 0.41379
Epoch 83/300
157/157 [==============================] - 3s 18ms/step - loss: 11.2755 - acc: 0.2834 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00083: val_acc did not improve from 0.41379
Epoch 84/300
157/157 [==============================] - 3s 17ms/step - loss: 11.0996 - acc: 0.2994 - val_loss: 12.2645 - val_acc:
0.2069

Epoch 00084: val_acc did not improve from 0.41379
Epoch 85/300
157/157 [==============================] - 3s 18ms/step - loss: 10.2738 - acc: 0.3392 - val_loss: 12.6354 - val_acc:
0.1897

Epoch 00085: val_acc did not improve from 0.41379
Epoch 86/300
157/157 [==============================] - 3s 18ms/step - loss: 10.7057 - acc: 0.3233 - val_loss: 10.3320 - val_acc:
0.3448

Epoch 00086: val_acc did not improve from 0.41379
Epoch 87/300
157/157 [==============================] - 3s 18ms/step - loss: 10.6533 - acc: 0.3312 - val_loss: 7.9981 - val_acc:
```

```
0.5000

Epoch 00087: val_acc improved from 0.41379 to 0.50000, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_2.h5
Epoch 88/300
157/157 [==============================] - 3s 18ms/step - loss: 11.1440 - acc: 0.2898 - val_loss: 7.6808 - val_acc:
0.5000

Epoch 00088: val_acc did not improve from 0.50000
Epoch 89/300
157/157 [==============================] - 3s 17ms/step - loss: 11.1610 - acc: 0.2898 - val_loss: 10.5602 - val_acc:
0.3448

Epoch 00089: val_acc did not improve from 0.50000
Epoch 90/300
157/157 [==============================] - 3s 17ms/step - loss: 10.8200 - acc: 0.3169 - val_loss: 10.4567 - val_acc:
0.3448

Epoch 00090: val_acc did not improve from 0.50000
Epoch 91/300
157/157 [==============================] - 3s 17ms/step - loss: 10.4382 - acc: 0.3360 - val_loss: 11.0451 - val_acc:
0.3103

Epoch 00091: val_acc did not improve from 0.50000
Epoch 92/300
157/157 [==============================] - 3s 18ms/step - loss: 10.4218 - acc: 0.3360 - val_loss: 11.3943 - val_acc:
0.2931

Epoch 00092: val_acc did not improve from 0.50000
Epoch 93/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4216 - acc: 0.3997 - val_loss: 9.7279 - val_acc: 0.
3966

Epoch 00093: val_acc did not improve from 0.50000
Epoch 94/300
157/157 [==============================] - 3s 17ms/step - loss: 9.8699 - acc: 0.3774 - val_loss: 8.3386 - val_acc: 0.
4828

Epoch 00094: val_acc did not improve from 0.50000
Epoch 95/300
157/157 [==============================] - 3s 17ms/step - loss: 9.9959 - acc: 0.3662 - val_loss: 12.5880 - val_acc:
0.2069
```

```
Epoch 00095: val_acc did not improve from 0.50000
Epoch 96/300
157/157 [==============================] - 3s 18ms/step - loss: 9.6634 - acc: 0.3949 - val_loss: 9.9074 - val_acc: 0.
3793

Epoch 00096: val_acc did not improve from 0.50000
Epoch 97/300
157/157 [==============================] - 3s 17ms/step - loss: 10.4357 - acc: 0.3424 - val_loss: 9.4488 - val_acc:
0.4138

Epoch 00097: val_acc did not improve from 0.50000
Epoch 98/300
157/157 [==============================] - 3s 18ms/step - loss: 10.0485 - acc: 0.3583 - val_loss: 8.8839 - val_acc:
0.4483

Epoch 00098: val_acc did not improve from 0.50000
Epoch 99/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7139 - acc: 0.3870 - val_loss: 8.1358 - val_acc: 0.
4828

Epoch 00099: val_acc did not improve from 0.50000
Epoch 100/300
157/157 [==============================] - 3s 17ms/step - loss: 9.9452 - acc: 0.3726 - val_loss: 8.7625 - val_acc: 0.
4483

Epoch 00100: val_acc did not improve from 0.50000
Epoch 101/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8394 - acc: 0.3822 - val_loss: 9.6016 - val_acc: 0.
3966

Epoch 00101: val_acc did not improve from 0.50000
Epoch 102/300
157/157 [==============================] - 3s 18ms/step - loss: 9.9564 - acc: 0.3678 - val_loss: 9.4485 - val_acc: 0.
4138

Epoch 00102: val_acc did not improve from 0.50000
Epoch 103/300
157/157 [==============================] - 3s 18ms/step - loss: 11.0383 - acc: 0.3026 - val_loss: 6.9475 - val_acc:
0.5690

Epoch 00103: val_acc improved from 0.50000 to 0.56897, saving model to /content/drive/My Drive/Leaf Disease Classific
```

ation/Results/Results-Cropped/model_2.h5
Epoch 104/300
157/157 [==============================] - 3s 18ms/step - loss: 10.4116 - acc: 0.3424 - val_loss: 9.3416 - val_acc:
0.4138

Epoch 00104: val_acc did not improve from 0.56897
Epoch 105/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8197 - acc: 0.3774 - val_loss: 10.1394 - val_acc:
0.3621

Epoch 00105: val_acc did not improve from 0.56897
Epoch 106/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1865 - acc: 0.3567 - val_loss: 8.6148 - val_acc:
0.4655

Epoch 00106: val_acc did not improve from 0.56897
Epoch 107/300
157/157 [==============================] - 3s 18ms/step - loss: 9.2408 - acc: 0.4140 - val_loss: 7.5034 - val_acc: 0.
5345

Epoch 00107: val_acc did not improve from 0.56897
Epoch 108/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1247 - acc: 0.3583 - val_loss: 8.6148 - val_acc:
0.4655

Epoch 00108: val_acc did not improve from 0.56897
Epoch 109/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1864 - acc: 0.3583 - val_loss: 8.8197 - val_acc:
0.4138

Epoch 00109: val_acc did not improve from 0.56897
Epoch 110/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7106 - acc: 0.3853 - val_loss: 8.7213 - val_acc: 0.
4310

Epoch 00110: val_acc did not improve from 0.56897
Epoch 111/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3507 - acc: 0.4108 - val_loss: 7.9956 - val_acc: 0.
5000

Epoch 00111: val_acc did not improve from 0.56897
Epoch 112/300

```
157/157 [==============================] - 3s 18ms/step - loss: 10.0775 - acc: 0.3599 - val_loss: 11.3079 - val_acc:
0.2931

Epoch 00112: val_acc did not improve from 0.56897
Epoch 113/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8814 - acc: 0.3758 - val_loss: 7.9058 - val_acc: 0.
5000

Epoch 00113: val_acc did not improve from 0.56897
Epoch 114/300
157/157 [==============================] - 3s 17ms/step - loss: 9.3400 - acc: 0.4029 - val_loss: 8.1092 - val_acc: 0.
4828

Epoch 00114: val_acc did not improve from 0.56897
Epoch 115/300
157/157 [==============================] - 3s 17ms/step - loss: 9.8928 - acc: 0.3710 - val_loss: 6.7133 - val_acc: 0.
5690

Epoch 00115: val_acc did not improve from 0.56897
Epoch 116/300
157/157 [==============================] - 3s 17ms/step - loss: 9.5184 - acc: 0.3981 - val_loss: 6.9520 - val_acc: 0.
5690

Epoch 00116: val_acc did not improve from 0.56897
Epoch 117/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4949 - acc: 0.3997 - val_loss: 8.6160 - val_acc: 0.
4655

Epoch 00117: val_acc did not improve from 0.56897
Epoch 118/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7785 - acc: 0.3838 - val_loss: 7.5050 - val_acc: 0.
5345

Epoch 00118: val_acc did not improve from 0.56897
Epoch 119/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1580 - acc: 0.3551 - val_loss: 8.4494 - val_acc:
0.4655

Epoch 00119: val_acc did not improve from 0.56897
Epoch 120/300
157/157 [==============================] - 3s 18ms/step - loss: 9.6604 - acc: 0.3933 - val_loss: 9.3299 - val_acc: 0.
4138
```

```
Epoch 00120: val_acc did not improve from 0.56897
Epoch 121/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1163 - acc: 0.3662 - val_loss: 9.9841 - val_acc:
0.3621

Epoch 00121: val_acc did not improve from 0.56897
Epoch 122/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4371 - acc: 0.4045 - val_loss: 8.9343 - val_acc: 0.
4310

Epoch 00122: val_acc did not improve from 0.56897
Epoch 123/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7808 - acc: 0.3869 - val_loss: 9.2792 - val_acc: 0.
4138

Epoch 00123: val_acc did not improve from 0.56897
Epoch 124/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1792 - acc: 0.3567 - val_loss: 8.6149 - val_acc:
0.4655

Epoch 00124: val_acc did not improve from 0.56897
Epoch 125/300
157/157 [==============================] - 3s 18ms/step - loss: 10.0968 - acc: 0.3662 - val_loss: 9.7264 - val_acc:
0.3966

Epoch 00125: val_acc did not improve from 0.56897
Epoch 126/300
157/157 [==============================] - 3s 18ms/step - loss: 9.9416 - acc: 0.3726 - val_loss: 10.6676 - val_acc:
0.3276

Epoch 00126: val_acc did not improve from 0.56897
Epoch 127/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1893 - acc: 0.3583 - val_loss: 8.3386 - val_acc:
0.4828

Epoch 00127: val_acc did not improve from 0.56897
Epoch 128/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7094 - acc: 0.3901 - val_loss: 8.3875 - val_acc: 0.
4655

Epoch 00128: val_acc did not improve from 0.56897
```

```
Epoch 129/300
157/157 [==============================] - 3s 18ms/step - loss: 9.5244 - acc: 0.4061 - val_loss: 8.8927 - val_acc: 0.
4483

Epoch 00129: val_acc did not improve from 0.56897
Epoch 130/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4221 - acc: 0.4060 - val_loss: 8.8974 - val_acc: 0.
4310

Epoch 00130: val_acc did not improve from 0.56897
Epoch 131/300
157/157 [==============================] - 3s 18ms/step - loss: 10.1309 - acc: 0.3519 - val_loss: 11.3939 - val_acc:
0.2931

Epoch 00131: val_acc did not improve from 0.56897
Epoch 132/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8430 - acc: 0.3869 - val_loss: 7.9511 - val_acc: 0.
5000

Epoch 00132: val_acc did not improve from 0.56897
Epoch 133/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4555 - acc: 0.3981 - val_loss: 8.3370 - val_acc: 0.
4828

Epoch 00133: val_acc did not improve from 0.56897
Epoch 134/300
157/157 [==============================] - 3s 18ms/step - loss: 9.5282 - acc: 0.3965 - val_loss: 8.1016 - val_acc: 0.
4828

Epoch 00134: val_acc did not improve from 0.56897
Epoch 135/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8634 - acc: 0.3790 - val_loss: 8.9513 - val_acc: 0.
4310

Epoch 00135: val_acc did not improve from 0.56897
Epoch 136/300
157/157 [==============================] - 3s 17ms/step - loss: 9.2531 - acc: 0.4172 - val_loss: 9.4406 - val_acc: 0.
3966

Epoch 00136: val_acc did not improve from 0.56897
Epoch 137/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0928 - acc: 0.4299 - val_loss: 8.4797 - val_acc: 0.
```

```
4655


Epoch 00137: val_acc did not improve from 0.56897
Epoch 138/300
157/157 [==============================] - 3s 17ms/step - loss: 9.1869 - acc: 0.4220 - val_loss: 7.9771 - val_acc: 0.
5000


Epoch 00138: val_acc did not improve from 0.56897
Epoch 139/300
157/157 [==============================] - 3s 17ms/step - loss: 9.8432 - acc: 0.3790 - val_loss: 5.5580 - val_acc: 0.
6552


Epoch 00139: val_acc improved from 0.56897 to 0.65517, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_2.h5
Epoch 140/300
157/157 [==============================] - 3s 17ms/step - loss: 10.0331 - acc: 0.3726 - val_loss: 6.7985 - val_acc:
0.5690


Epoch 00140: val_acc did not improve from 0.65517
Epoch 141/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3463 - acc: 0.4124 - val_loss: 7.7973 - val_acc: 0.
5000


Epoch 00141: val_acc did not improve from 0.65517
Epoch 142/300
157/157 [==============================] - 3s 17ms/step - loss: 9.8682 - acc: 0.3854 - val_loss: 9.1706 - val_acc: 0.
4310


Epoch 00142: val_acc did not improve from 0.65517
Epoch 143/300
157/157 [==============================] - 3s 18ms/step - loss: 9.1847 - acc: 0.4156 - val_loss: 9.1333 - val_acc: 0.
4310


Epoch 00143: val_acc did not improve from 0.65517
Epoch 144/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8272 - acc: 0.3853 - val_loss: 6.9475 - val_acc: 0.
5690


Epoch 00144: val_acc did not improve from 0.65517
Epoch 145/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0579 - acc: 0.4315 - val_loss: 7.0821 - val_acc: 0.
5345
```

```
Epoch 00145: val_acc did not improve from 0.65517
Epoch 146/300
157/157 [==============================] - 3s 17ms/step - loss: 9.3228 - acc: 0.4156 - val_loss: 8.0590 - val_acc: 0.
5000

Epoch 00146: val_acc did not improve from 0.65517
Epoch 147/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8249 - acc: 0.4411 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00147: val_acc did not improve from 0.65517
Epoch 148/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3659 - acc: 0.4092 - val_loss: 8.8927 - val_acc: 0.
4483

Epoch 00148: val_acc did not improve from 0.65517
Epoch 149/300
157/157 [==============================] - 3s 18ms/step - loss: 9.2658 - acc: 0.4108 - val_loss: 5.8359 - val_acc: 0.
6379

Epoch 00149: val_acc did not improve from 0.65517
Epoch 150/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7686 - acc: 0.3885 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00150: val_acc did not improve from 0.65517
Epoch 151/300
157/157 [==============================] - 3s 17ms/step - loss: 9.5806 - acc: 0.3981 - val_loss: 7.1303 - val_acc: 0.
5345

Epoch 00151: val_acc did not improve from 0.65517
Epoch 152/300
157/157 [==============================] - 3s 18ms/step - loss: 9.1369 - acc: 0.4204 - val_loss: 6.5454 - val_acc: 0.
5862

Epoch 00152: val_acc did not improve from 0.65517
Epoch 153/300
157/157 [==============================] - 3s 17ms/step - loss: 9.7544 - acc: 0.3885 - val_loss: 10.0082 - val_acc:
0.3793

Epoch 00153: val_acc did not improve from 0.65517
```

```
Epoch 154/300
157/157 [==============================] - 3s 17ms/step - loss: 9.9421 - acc: 0.3774 - val_loss: 7.2271 - val_acc: 0.
5517

Epoch 00154: val_acc did not improve from 0.65517
Epoch 155/300
157/157 [==============================] - 3s 17ms/step - loss: 9.5107 - acc: 0.4045 - val_loss: 8.7521 - val_acc: 0.
4483

Epoch 00155: val_acc did not improve from 0.65517
Epoch 156/300
157/157 [==============================] - 3s 18ms/step - loss: 9.5028 - acc: 0.4092 - val_loss: 6.5541 - val_acc: 0.
5862

Epoch 00156: val_acc did not improve from 0.65517
Epoch 157/300
157/157 [==============================] - 3s 17ms/step - loss: 9.8220 - acc: 0.3854 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00157: val_acc did not improve from 0.65517
Epoch 158/300
157/157 [==============================] - 3s 17ms/step - loss: 10.5450 - acc: 0.3392 - val_loss: 8.0879 - val_acc:
0.4828

Epoch 00158: val_acc did not improve from 0.65517
Epoch 159/300
157/157 [==============================] - 3s 17ms/step - loss: 9.6933 - acc: 0.3933 - val_loss: 7.5033 - val_acc: 0.
5345

Epoch 00159: val_acc did not improve from 0.65517
Epoch 160/300
157/157 [==============================] - 3s 18ms/step - loss: 9.6565 - acc: 0.3917 - val_loss: 6.6696 - val_acc: 0.
5862

Epoch 00160: val_acc did not improve from 0.65517
Epoch 161/300
157/157 [==============================] - 3s 17ms/step - loss: 8.9652 - acc: 0.4379 - val_loss: 6.6889 - val_acc: 0.
5690

Epoch 00161: val_acc did not improve from 0.65517
Epoch 162/300
157/157 [==============================] - 3s 18ms/step - loss: 9.2297 - acc: 0.4204 - val_loss: 6.3917 - val_acc: 0.
```

6034

Epoch 00162: val_acc did not improve from 0.65517
Epoch 163/300
157/157 [==============================] - 3s 18ms/step - loss: 9.6006 - acc: 0.3933 - val_loss: 7.7272 - val_acc: 0.5172

Epoch 00163: val_acc did not improve from 0.65517
Epoch 164/300
157/157 [==============================] - 3s 18ms/step - loss: 9.2773 - acc: 0.4156 - val_loss: 9.1053 - val_acc: 0.4310

Epoch 00164: val_acc did not improve from 0.65517
Epoch 165/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7520 - acc: 0.3870 - val_loss: 7.8105 - val_acc: 0.5000

Epoch 00165: val_acc did not improve from 0.65517
Epoch 166/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8175 - acc: 0.3790 - val_loss: 11.0341 - val_acc: 0.3103

Epoch 00166: val_acc did not improve from 0.65517
Epoch 167/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4686 - acc: 0.4060 - val_loss: 12.5420 - val_acc: 0.2069

Epoch 00167: val_acc did not improve from 0.65517
Epoch 168/300
157/157 [==============================] - 3s 18ms/step - loss: 10.3396 - acc: 0.3535 - val_loss: 13.3391 - val_acc: 0.1724

Epoch 00168: val_acc did not improve from 0.65517
Epoch 169/300
157/157 [==============================] - 3s 18ms/step - loss: 10.4106 - acc: 0.3519 - val_loss: 11.3938 - val_acc: 0.2931

Epoch 00169: val_acc did not improve from 0.65517
Epoch 170/300
157/157 [==============================] - 3s 17ms/step - loss: 9.2540 - acc: 0.4172 - val_loss: 7.7811 - val_acc: 0.5172

```
Epoch 00170: val_acc did not improve from 0.65517
Epoch 171/300
157/157 [==============================] - 3s 18ms/step - loss: 9.2730 - acc: 0.4172 - val_loss: 10.2003 - val_acc:
0.3621

Epoch 00171: val_acc did not improve from 0.65517
Epoch 172/300
157/157 [==============================] - 3s 18ms/step - loss: 8.7507 - acc: 0.4522 - val_loss: 9.2996 - val_acc: 0.
4138

Epoch 00172: val_acc did not improve from 0.65517
Epoch 173/300
157/157 [==============================] - 3s 17ms/step - loss: 9.1494 - acc: 0.4220 - val_loss: 8.8396 - val_acc: 0.
4483

Epoch 00173: val_acc did not improve from 0.65517
Epoch 174/300
157/157 [==============================] - 3s 17ms/step - loss: 9.5461 - acc: 0.4029 - val_loss: 12.2275 - val_acc:
0.2414

Epoch 00174: val_acc did not improve from 0.65517
Epoch 175/300
157/157 [==============================] - 3s 18ms/step - loss: 9.9089 - acc: 0.3790 - val_loss: 10.4499 - val_acc:
0.3448

Epoch 00175: val_acc did not improve from 0.65517
Epoch 176/300
157/157 [==============================] - 3s 18ms/step - loss: 9.1178 - acc: 0.4267 - val_loss: 9.4547 - val_acc: 0.
4138

Epoch 00176: val_acc did not improve from 0.65517
Epoch 177/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4345 - acc: 0.4061 - val_loss: 8.5002 - val_acc: 0.
4483

Epoch 00177: val_acc did not improve from 0.65517
Epoch 178/300
157/157 [==============================] - 3s 18ms/step - loss: 9.6134 - acc: 0.3981 - val_loss: 9.4485 - val_acc: 0.
4138

Epoch 00178: val_acc did not improve from 0.65517
Epoch 179/300
```

```
157/157 [==============================] - 3s 18ms/step - loss: 9.8875 - acc: 0.3838 - val_loss: 8.8928 - val_acc: 0.
4483

Epoch 00179: val_acc did not improve from 0.65517
Epoch 180/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0603 - acc: 0.4299 - val_loss: 7.6366 - val_acc: 0.
5172

Epoch 00180: val_acc did not improve from 0.65517
Epoch 181/300
157/157 [==============================] - 3s 18ms/step - loss: 9.1812 - acc: 0.4220 - val_loss: 8.8290 - val_acc: 0.
4483

Epoch 00181: val_acc did not improve from 0.65517
Epoch 182/300
157/157 [==============================] - 3s 18ms/step - loss: 9.5834 - acc: 0.3997 - val_loss: 8.4165 - val_acc: 0.
4655

Epoch 00182: val_acc did not improve from 0.65517
Epoch 183/300
157/157 [==============================] - 3s 17ms/step - loss: 9.2839 - acc: 0.4156 - val_loss: 8.0315 - val_acc: 0.
5000

Epoch 00183: val_acc did not improve from 0.65517
Epoch 184/300
157/157 [==============================] - 3s 18ms/step - loss: 9.7988 - acc: 0.3838 - val_loss: 12.8073 - val_acc:
0.1897

Epoch 00184: val_acc did not improve from 0.65517
Epoch 185/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4814 - acc: 0.4076 - val_loss: 7.5033 - val_acc: 0.
5345

Epoch 00185: val_acc did not improve from 0.65517
Epoch 186/300
157/157 [==============================] - 3s 18ms/step - loss: 8.6842 - acc: 0.4570 - val_loss: 8.0590 - val_acc: 0.
5000

Epoch 00186: val_acc did not improve from 0.65517
Epoch 187/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8721 - acc: 0.4427 - val_loss: 8.8768 - val_acc: 0.
4483
```

```
Epoch 00187: val_acc did not improve from 0.65517
Epoch 188/300
157/157 [==============================] - 3s 17ms/step - loss: 9.1018 - acc: 0.4315 - val_loss: 7.7428 - val_acc: 0.
5000

Epoch 00188: val_acc did not improve from 0.65517
Epoch 189/300
157/157 [==============================] - 3s 17ms/step - loss: 8.9277 - acc: 0.4379 - val_loss: 7.4260 - val_acc: 0.
5345

Epoch 00189: val_acc did not improve from 0.65517
Epoch 190/300
157/157 [==============================] - 3s 17ms/step - loss: 8.4228 - acc: 0.4697 - val_loss: 6.9475 - val_acc: 0.
5690

Epoch 00190: val_acc did not improve from 0.65517
Epoch 191/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9987 - acc: 0.4347 - val_loss: 9.7264 - val_acc: 0.
3966

Epoch 00191: val_acc did not improve from 0.65517
Epoch 192/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9237 - acc: 0.4411 - val_loss: 7.5044 - val_acc: 0.
5345

Epoch 00192: val_acc did not improve from 0.65517
Epoch 193/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4484 - acc: 0.4124 - val_loss: 7.1955 - val_acc: 0.
5517

Epoch 00193: val_acc did not improve from 0.65517
Epoch 194/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8733 - acc: 0.4443 - val_loss: 6.3827 - val_acc: 0.
5862

Epoch 00194: val_acc did not improve from 0.65517
Epoch 195/300
157/157 [==============================] - 3s 17ms/step - loss: 9.0362 - acc: 0.4331 - val_loss: 6.4807 - val_acc: 0.
5862

Epoch 00195: val_acc did not improve from 0.65517
```

```
Epoch 196/300
157/157 [==============================] - 3s 17ms/step - loss: 9.0558 - acc: 0.4315 - val_loss: 11.3929 - val_acc:
0.2931

Epoch 00196: val_acc did not improve from 0.65517
Epoch 197/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8118 - acc: 0.4443 - val_loss: 8.3369 - val_acc: 0.
4828

Epoch 00197: val_acc did not improve from 0.65517
Epoch 198/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8446 - acc: 0.4475 - val_loss: 7.2460 - val_acc: 0.
5345

Epoch 00198: val_acc did not improve from 0.65517
Epoch 199/300
157/157 [==============================] - 3s 17ms/step - loss: 9.2057 - acc: 0.4268 - val_loss: 6.3917 - val_acc: 0.
6034

Epoch 00199: val_acc did not improve from 0.65517
Epoch 200/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8436 - acc: 0.4490 - val_loss: 6.9488 - val_acc: 0.
5690

Epoch 00200: val_acc did not improve from 0.65517
Epoch 201/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3720 - acc: 0.4140 - val_loss: 7.7123 - val_acc: 0.
5172

Epoch 00201: val_acc did not improve from 0.65517
Epoch 202/300
157/157 [==============================] - 3s 18ms/step - loss: 8.4643 - acc: 0.4697 - val_loss: 8.3400 - val_acc: 0.
4828

Epoch 00202: val_acc did not improve from 0.65517
Epoch 203/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0343 - acc: 0.4347 - val_loss: 7.7245 - val_acc: 0.
5172

Epoch 00203: val_acc did not improve from 0.65517
Epoch 204/300
157/157 [==============================] - 3s 18ms/step - loss: 8.4122 - acc: 0.4745 - val_loss: 7.7815 - val_acc: 0.
```

5172

Epoch 00204: val_acc did not improve from 0.65517
Epoch 205/300
157/157 [==============================] - 3s 18ms/step - loss: 8.6381 - acc: 0.4602 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00205: val_acc did not improve from 0.65517
Epoch 206/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8517 - acc: 0.4443 - val_loss: 6.9475 - val_acc: 0.
5690

Epoch 00206: val_acc did not improve from 0.65517
Epoch 207/300
157/157 [==============================] - 3s 17ms/step - loss: 8.7013 - acc: 0.4522 - val_loss: 6.3927 - val_acc: 0.
6034

Epoch 00207: val_acc did not improve from 0.65517
Epoch 208/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3767 - acc: 0.4108 - val_loss: 8.9411 - val_acc: 0.
4310

Epoch 00208: val_acc did not improve from 0.65517
Epoch 209/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8829 - acc: 0.3790 - val_loss: 7.7505 - val_acc: 0.
5000

Epoch 00209: val_acc did not improve from 0.65517
Epoch 210/300
157/157 [==============================] - 3s 17ms/step - loss: 8.6491 - acc: 0.4554 - val_loss: 10.5601 - val_acc:
0.3448

Epoch 00210: val_acc did not improve from 0.65517
Epoch 211/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0575 - acc: 0.4283 - val_loss: 9.9348 - val_acc: 0.
3793

Epoch 00211: val_acc did not improve from 0.65517
Epoch 212/300
157/157 [==============================] - 3s 17ms/step - loss: 9.1146 - acc: 0.4268 - val_loss: 8.8670 - val_acc: 0.
4483

```
Epoch 00212: val_acc did not improve from 0.65517
Epoch 213/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9502 - acc: 0.4379 - val_loss: 7.4143 - val_acc: 0.
5345

Epoch 00213: val_acc did not improve from 0.65517
Epoch 214/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8693 - acc: 0.4459 - val_loss: 6.9292 - val_acc: 0.
5690

Epoch 00214: val_acc did not improve from 0.65517
Epoch 215/300
157/157 [==============================] - 3s 18ms/step - loss: 9.1884 - acc: 0.4267 - val_loss: 6.6698 - val_acc: 0.
5862

Epoch 00215: val_acc did not improve from 0.65517
Epoch 216/300
157/157 [==============================] - 3s 18ms/step - loss: 9.4477 - acc: 0.4108 - val_loss: 7.5033 - val_acc: 0.
5345

Epoch 00216: val_acc did not improve from 0.65517
Epoch 217/300
157/157 [==============================] - 3s 17ms/step - loss: 9.2113 - acc: 0.4156 - val_loss: 8.0656 - val_acc: 0.
5000

Epoch 00217: val_acc did not improve from 0.65517
Epoch 218/300
157/157 [==============================] - 3s 18ms/step - loss: 9.8139 - acc: 0.3838 - val_loss: 8.8927 - val_acc: 0.
4483

Epoch 00218: val_acc did not improve from 0.65517
Epoch 219/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0336 - acc: 0.4347 - val_loss: 8.6148 - val_acc: 0.
4655

Epoch 00219: val_acc did not improve from 0.65517
Epoch 220/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8447 - acc: 0.4475 - val_loss: 6.9642 - val_acc: 0.
5517

Epoch 00220: val_acc did not improve from 0.65517
Epoch 221/300
```

157/157 [==============================] - 3s 18ms/step - loss: 9.1382 - acc: 0.4284 - val_loss: 7.7822 - val_acc: 0.
5172

Epoch 00221: val_acc did not improve from 0.65517
Epoch 222/300
157/157 [==============================] - 3s 17ms/step - loss: 8.7682 - acc: 0.4475 - val_loss: 12.5054 - val_acc:
0.2241

Epoch 00222: val_acc did not improve from 0.65517
Epoch 223/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9043 - acc: 0.4443 - val_loss: 9.7264 - val_acc: 0.
3966

Epoch 00223: val_acc did not improve from 0.65517
Epoch 224/300
157/157 [==============================] - 3s 18ms/step - loss: 8.5293 - acc: 0.4618 - val_loss: 7.7811 - val_acc: 0.
5172

Epoch 00224: val_acc did not improve from 0.65517
Epoch 225/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3414 - acc: 0.4172 - val_loss: 7.5033 - val_acc: 0.
5345

Epoch 00225: val_acc did not improve from 0.65517
Epoch 226/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8445 - acc: 0.4411 - val_loss: 8.0590 - val_acc: 0.
5000

Epoch 00226: val_acc did not improve from 0.65517
Epoch 227/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0676 - acc: 0.4363 - val_loss: 8.0591 - val_acc: 0.
5000

Epoch 00227: val_acc did not improve from 0.65517
Epoch 228/300
157/157 [==============================] - 3s 17ms/step - loss: 8.2978 - acc: 0.4777 - val_loss: 7.7823 - val_acc: 0.
5172

Epoch 00228: val_acc did not improve from 0.65517
Epoch 229/300
157/157 [==============================] - 3s 18ms/step - loss: 8.7768 - acc: 0.4491 - val_loss: 9.2545 - val_acc: 0.
4138

```
Epoch 00229: val_acc did not improve from 0.65517
Epoch 230/300
157/157 [==============================] - 3s 17ms/step - loss: 9.2184 - acc: 0.4252 - val_loss: 8.8928 - val_acc: 0.
4483

Epoch 00230: val_acc did not improve from 0.65517
Epoch 231/300
157/157 [==============================] - 3s 18ms/step - loss: 10.0518 - acc: 0.3726 - val_loss: 8.1413 - val_acc:
0.4828

Epoch 00231: val_acc did not improve from 0.65517
Epoch 232/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9569 - acc: 0.4395 - val_loss: 6.3917 - val_acc: 0.
6034

Epoch 00232: val_acc did not improve from 0.65517
Epoch 233/300
157/157 [==============================] - 3s 18ms/step - loss: 8.7500 - acc: 0.4491 - val_loss: 8.8194 - val_acc: 0.
4310

Epoch 00233: val_acc did not improve from 0.65517
Epoch 234/300
157/157 [==============================] - 3s 17ms/step - loss: 9.1841 - acc: 0.4220 - val_loss: 7.7811 - val_acc: 0.
5172

Epoch 00234: val_acc did not improve from 0.65517
Epoch 235/300
157/157 [==============================] - 3s 17ms/step - loss: 8.3715 - acc: 0.4777 - val_loss: 6.9475 - val_acc: 0.
5690

Epoch 00235: val_acc did not improve from 0.65517
Epoch 236/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9220 - acc: 0.4347 - val_loss: 7.7854 - val_acc: 0.
5172

Epoch 00236: val_acc did not improve from 0.65517
Epoch 237/300
157/157 [==============================] - 3s 18ms/step - loss: 8.4646 - acc: 0.4650 - val_loss: 8.9649 - val_acc: 0.
4138

Epoch 00237: val_acc did not improve from 0.65517
```

```
Epoch 238/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3807 - acc: 0.4108 - val_loss: 11.6717 - val_acc:
0.2759

Epoch 00238: val_acc did not improve from 0.65517
Epoch 239/300
157/157 [==============================] - 3s 17ms/step - loss: 10.2241 - acc: 0.3599 - val_loss: 6.6702 - val_acc:
0.5862

Epoch 00239: val_acc did not improve from 0.65517
Epoch 240/300
157/157 [==============================] - 3s 18ms/step - loss: 8.7668 - acc: 0.4506 - val_loss: 6.6048 - val_acc: 0.
5862

Epoch 00240: val_acc did not improve from 0.65517
Epoch 241/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3249 - acc: 0.4156 - val_loss: 7.8968 - val_acc: 0.
5000

Epoch 00241: val_acc did not improve from 0.65517
Epoch 242/300
157/157 [==============================] - 3s 18ms/step - loss: 9.1100 - acc: 0.4315 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00242: val_acc did not improve from 0.65517
Epoch 243/300
157/157 [==============================] - 3s 17ms/step - loss: 9.4750 - acc: 0.4076 - val_loss: 7.5033 - val_acc: 0.
5345

Epoch 00243: val_acc did not improve from 0.65517
Epoch 244/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8690 - acc: 0.4443 - val_loss: 7.7525 - val_acc: 0.
5000

Epoch 00244: val_acc did not improve from 0.65517
Epoch 245/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8842 - acc: 0.4411 - val_loss: 8.3369 - val_acc: 0.
4828

Epoch 00245: val_acc did not improve from 0.65517
Epoch 246/300
157/157 [==============================] - 3s 18ms/step - loss: 9.6449 - acc: 0.3965 - val_loss: 5.8359 - val_acc: 0.
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6379

Epoch 00246: val_acc did not improve from 0.65517
Epoch 247/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8487 - acc: 0.4443 - val_loss: 7.7811 - val_acc: 0.5172

Epoch 00247: val_acc did not improve from 0.65517
Epoch 248/300
157/157 [==============================] - 3s 18ms/step - loss: 8.7284 - acc: 0.4538 - val_loss: 7.5033 - val_acc: 0.5345

Epoch 00248: val_acc did not improve from 0.65517
Epoch 249/300
157/157 [==============================] - 3s 17ms/step - loss: 8.6546 - acc: 0.4570 - val_loss: 7.7811 - val_acc: 0.5172

Epoch 00249: val_acc did not improve from 0.65517
Epoch 250/300
157/157 [==============================] - 3s 18ms/step - loss: 9.0411 - acc: 0.4331 - val_loss: 6.6696 - val_acc: 0.5862

Epoch 00250: val_acc did not improve from 0.65517
Epoch 251/300
157/157 [==============================] - 3s 18ms/step - loss: 8.6551 - acc: 0.4586 - val_loss: 11.7689 - val_acc: 0.2586

Epoch 00251: val_acc did not improve from 0.65517
Epoch 252/300
157/157 [==============================] - 3s 17ms/step - loss: 9.0803 - acc: 0.4283 - val_loss: 6.1138 - val_acc: 0.6207

Epoch 00252: val_acc did not improve from 0.65517
Epoch 253/300
157/157 [==============================] - 3s 17ms/step - loss: 8.7999 - acc: 0.4427 - val_loss: 8.3369 - val_acc: 0.4828

Epoch 00253: val_acc did not improve from 0.65517
Epoch 254/300
157/157 [==============================] - 3s 17ms/step - loss: 9.2311 - acc: 0.4236 - val_loss: 8.3196 - val_acc: 0.4828

```
Epoch 00254: val_acc did not improve from 0.65517
Epoch 255/300
157/157 [==============================] - 3s 18ms/step - loss: 8.7869 - acc: 0.4506 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00255: val_acc did not improve from 0.65517
Epoch 256/300
157/157 [==============================] - 3s 17ms/step - loss: 9.0772 - acc: 0.4268 - val_loss: 8.1677 - val_acc: 0.
4828

Epoch 00256: val_acc did not improve from 0.65517
Epoch 257/300
157/157 [==============================] - 3s 17ms/step - loss: 9.0879 - acc: 0.4315 - val_loss: 8.8963 - val_acc: 0.
4483

Epoch 00257: val_acc did not improve from 0.65517
Epoch 258/300
157/157 [==============================] - 3s 18ms/step - loss: 9.2413 - acc: 0.4172 - val_loss: 6.7427 - val_acc: 0.
5690

Epoch 00258: val_acc did not improve from 0.65517
Epoch 259/300
157/157 [==============================] - 3s 17ms/step - loss: 8.3361 - acc: 0.4793 - val_loss: 8.0590 - val_acc: 0.
5000

Epoch 00259: val_acc did not improve from 0.65517
Epoch 260/300
157/157 [==============================] - 3s 18ms/step - loss: 8.4092 - acc: 0.4713 - val_loss: 6.7402 - val_acc: 0.
5690

Epoch 00260: val_acc did not improve from 0.65517
Epoch 261/300
157/157 [==============================] - 3s 17ms/step - loss: 9.1588 - acc: 0.4283 - val_loss: 8.8927 - val_acc: 0.
4483

Epoch 00261: val_acc did not improve from 0.65517
Epoch 262/300
157/157 [==============================] - 3s 17ms/step - loss: 8.9863 - acc: 0.4331 - val_loss: 5.2961 - val_acc: 0.
6552

Epoch 00262: val_acc did not improve from 0.65517
Epoch 263/300
```

```
157/157 [==============================] - 3s 18ms/step - loss: 8.9676 - acc: 0.4363 - val_loss: 6.8105 - val_acc: 0.
5690

Epoch 00263: val_acc did not improve from 0.65517
Epoch 264/300
157/157 [==============================] - 3s 17ms/step - loss: 9.4752 - acc: 0.4076 - val_loss: 8.3011 - val_acc: 0.
4828

Epoch 00264: val_acc did not improve from 0.65517
Epoch 265/300
157/157 [==============================] - 3s 18ms/step - loss: 8.0960 - acc: 0.4920 - val_loss: 5.9254 - val_acc: 0.
6207

Epoch 00265: val_acc did not improve from 0.65517
Epoch 266/300
157/157 [==============================] - 3s 17ms/step - loss: 8.6782 - acc: 0.4522 - val_loss: 6.1138 - val_acc: 0.
6207

Epoch 00266: val_acc did not improve from 0.65517
Epoch 267/300
157/157 [==============================] - 3s 18ms/step - loss: 8.8598 - acc: 0.4475 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00267: val_acc did not improve from 0.65517
Epoch 268/300
157/157 [==============================] - 3s 18ms/step - loss: 8.3479 - acc: 0.4777 - val_loss: 7.7827 - val_acc: 0.
5172

Epoch 00268: val_acc did not improve from 0.65517
Epoch 269/300
157/157 [==============================] - 3s 17ms/step - loss: 8.9547 - acc: 0.4395 - val_loss: 12.0824 - val_acc:
0.2414

Epoch 00269: val_acc did not improve from 0.65517
Epoch 270/300
157/157 [==============================] - 3s 18ms/step - loss: 8.4036 - acc: 0.4729 - val_loss: 7.2396 - val_acc: 0.
5345

Epoch 00270: val_acc did not improve from 0.65517
Epoch 271/300
157/157 [==============================] - 3s 17ms/step - loss: 8.3178 - acc: 0.4825 - val_loss: 8.6148 - val_acc: 0.
4655
```

```
Epoch 00271: val_acc did not improve from 0.65517
Epoch 272/300
157/157 [==============================] - 3s 18ms/step - loss: 9.3846 - acc: 0.4156 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00272: val_acc did not improve from 0.65517
Epoch 273/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9957 - acc: 0.4363 - val_loss: 7.7812 - val_acc: 0.
5172

Epoch 00273: val_acc did not improve from 0.65517
Epoch 274/300
157/157 [==============================] - 3s 17ms/step - loss: 9.8100 - acc: 0.3885 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00274: val_acc did not improve from 0.65517
Epoch 275/300
157/157 [==============================] - 3s 18ms/step - loss: 8.5254 - acc: 0.4586 - val_loss: 8.3369 - val_acc: 0.
4828

Epoch 00275: val_acc did not improve from 0.65517
Epoch 276/300
157/157 [==============================] - 3s 18ms/step - loss: 9.5163 - acc: 0.4076 - val_loss: 8.4637 - val_acc: 0.
4483

Epoch 00276: val_acc did not improve from 0.65517
Epoch 277/300
157/157 [==============================] - 3s 17ms/step - loss: 8.6095 - acc: 0.4634 - val_loss: 7.2391 - val_acc: 0.
5345

Epoch 00277: val_acc did not improve from 0.65517
Epoch 278/300
157/157 [==============================] - 3s 18ms/step - loss: 8.6261 - acc: 0.4618 - val_loss: 6.3917 - val_acc: 0.
6034

Epoch 00278: val_acc did not improve from 0.65517
Epoch 279/300
157/157 [==============================] - 3s 18ms/step - loss: 9.1450 - acc: 0.4315 - val_loss: 13.4866 - val_acc:
0.1552

Epoch 00279: val_acc did not improve from 0.65517
```

```
Epoch 280/300
157/157 [==============================] - 3s 18ms/step - loss: 8.1459 - acc: 0.4920 - val_loss: 7.5355 - val_acc: 0.
5172

Epoch 00280: val_acc did not improve from 0.65517
Epoch 281/300
157/157 [==============================] - 3s 18ms/step - loss: 8.1363 - acc: 0.4904 - val_loss: 7.0189 - val_acc: 0.
5517

Epoch 00281: val_acc did not improve from 0.65517
Epoch 282/300
157/157 [==============================] - 3s 18ms/step - loss: 8.4973 - acc: 0.4682 - val_loss: 7.6502 - val_acc: 0.
5172

Epoch 00282: val_acc did not improve from 0.65517
Epoch 283/300
157/157 [==============================] - 3s 17ms/step - loss: 8.7886 - acc: 0.4474 - val_loss: 9.4106 - val_acc: 0.
3966

Epoch 00283: val_acc did not improve from 0.65517
Epoch 284/300
157/157 [==============================] - 3s 18ms/step - loss: 8.0442 - acc: 0.4904 - val_loss: 6.9475 - val_acc: 0.
5690

Epoch 00284: val_acc did not improve from 0.65517
Epoch 285/300
157/157 [==============================] - 3s 18ms/step - loss: 8.3383 - acc: 0.4777 - val_loss: 9.7266 - val_acc: 0.
3966

Epoch 00285: val_acc did not improve from 0.65517
Epoch 286/300
157/157 [==============================] - 3s 18ms/step - loss: 7.9725 - acc: 0.5000 - val_loss: 7.2254 - val_acc: 0.
5517

Epoch 00286: val_acc did not improve from 0.65517
Epoch 287/300
157/157 [==============================] - 3s 17ms/step - loss: 8.2113 - acc: 0.4841 - val_loss: 9.4485 - val_acc: 0.
4138

Epoch 00287: val_acc did not improve from 0.65517
Epoch 288/300
157/157 [==============================] - 3s 18ms/step - loss: 8.4208 - acc: 0.4697 - val_loss: 6.9475 - val_acc: 0.
```

```
5690

Epoch 00288: val_acc did not improve from 0.65517
Epoch 289/300
157/157 [==============================] - 3s 18ms/step - loss: 7.9815 - acc: 0.4968 - val_loss: 7.4663 - val_acc: 0.
5345

Epoch 00289: val_acc did not improve from 0.65517
Epoch 290/300
157/157 [==============================] - 3s 17ms/step - loss: 8.9020 - acc: 0.4395 - val_loss: 7.2926 - val_acc: 0.
5000

Epoch 00290: val_acc did not improve from 0.65517
Epoch 291/300
157/157 [==============================] - 3s 18ms/step - loss: 8.5351 - acc: 0.4634 - val_loss: 7.7143 - val_acc: 0.
5172

Epoch 00291: val_acc did not improve from 0.65517
Epoch 292/300
157/157 [==============================] - 3s 18ms/step - loss: 8.5528 - acc: 0.4665 - val_loss: 8.5598 - val_acc: 0.
4655

Epoch 00292: val_acc did not improve from 0.65517
Epoch 293/300
157/157 [==============================] - 3s 17ms/step - loss: 8.6227 - acc: 0.4586 - val_loss: 10.5601 - val_acc:
0.3448

Epoch 00293: val_acc did not improve from 0.65517
Epoch 294/300
157/157 [==============================] - 3s 17ms/step - loss: 9.5191 - acc: 0.4029 - val_loss: 8.0877 - val_acc: 0.
4828

Epoch 00294: val_acc did not improve from 0.65517
Epoch 295/300
157/157 [==============================] - 3s 17ms/step - loss: 8.6694 - acc: 0.4570 - val_loss: 8.8148 - val_acc: 0.
4483

Epoch 00295: val_acc did not improve from 0.65517
Epoch 296/300
157/157 [==============================] - 3s 17ms/step - loss: 8.7338 - acc: 0.4554 - val_loss: 7.7811 - val_acc: 0.
5172
```

```
Epoch 00296: val_acc did not improve from 0.65517
Epoch 297/300
157/157 [==============================] - 3s 18ms/step - loss: 8.2637 - acc: 0.4841 - val_loss: 7.7811 - val_acc: 0.
5172

Epoch 00297: val_acc did not improve from 0.65517
Epoch 298/300
157/157 [==============================] - 3s 17ms/step - loss: 8.3902 - acc: 0.4761 - val_loss: 7.5033 - val_acc: 0.
5345

Epoch 00298: val_acc did not improve from 0.65517
Epoch 299/300
157/157 [==============================] - 3s 17ms/step - loss: 8.1259 - acc: 0.4920 - val_loss: 7.2256 - val_acc: 0.
5517

Epoch 00299: val_acc did not improve from 0.65517
Epoch 300/300
157/157 [==============================] - 3s 18ms/step - loss: 8.9185 - acc: 0.4427 - val_loss: 6.9475 - val_acc: 0.
5690

Epoch 00300: val_acc did not improve from 0.65517
```

```
In [0]: sns.set()
        plt.plot(history.history['acc'], 'r')
        plt.plot(history.history['val_acc'], 'b')
        plt.legend({'Train Accuracy': 'r', 'Test Accuracy':'b'})
        plt.show()
        plt.plot(history.history['loss'], 'r')
        plt.plot(history.history['val_loss'], 'b')
        plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
        plt.show()
```
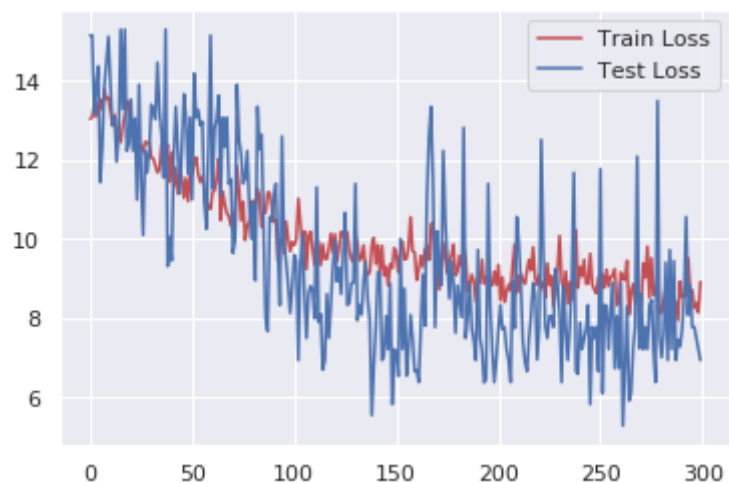
In [0]: `%load_ext tensorboard`

In [0]: `%tensorboard --logdir '/content/drive/My Drive/Leaf Disease Classification/Results/Results-Cropped/graph_2'`

Output hidden; open in https://colab.research.google.com to view.

In [0]: `model2.load_weights(path+'Results/Results-Cropped/model_2.h5')`

In [24]:
```
y_pred_tr = model2.predict(X_train)

y_tr2 = y_train.argmax(1)
y_pred_tr = y_pred_tr.argmax(1)

print("Train Accuracy: ", accuracy_score(y_tr2, y_pred_tr))
```

Train Accuracy: 0.49206349206349204
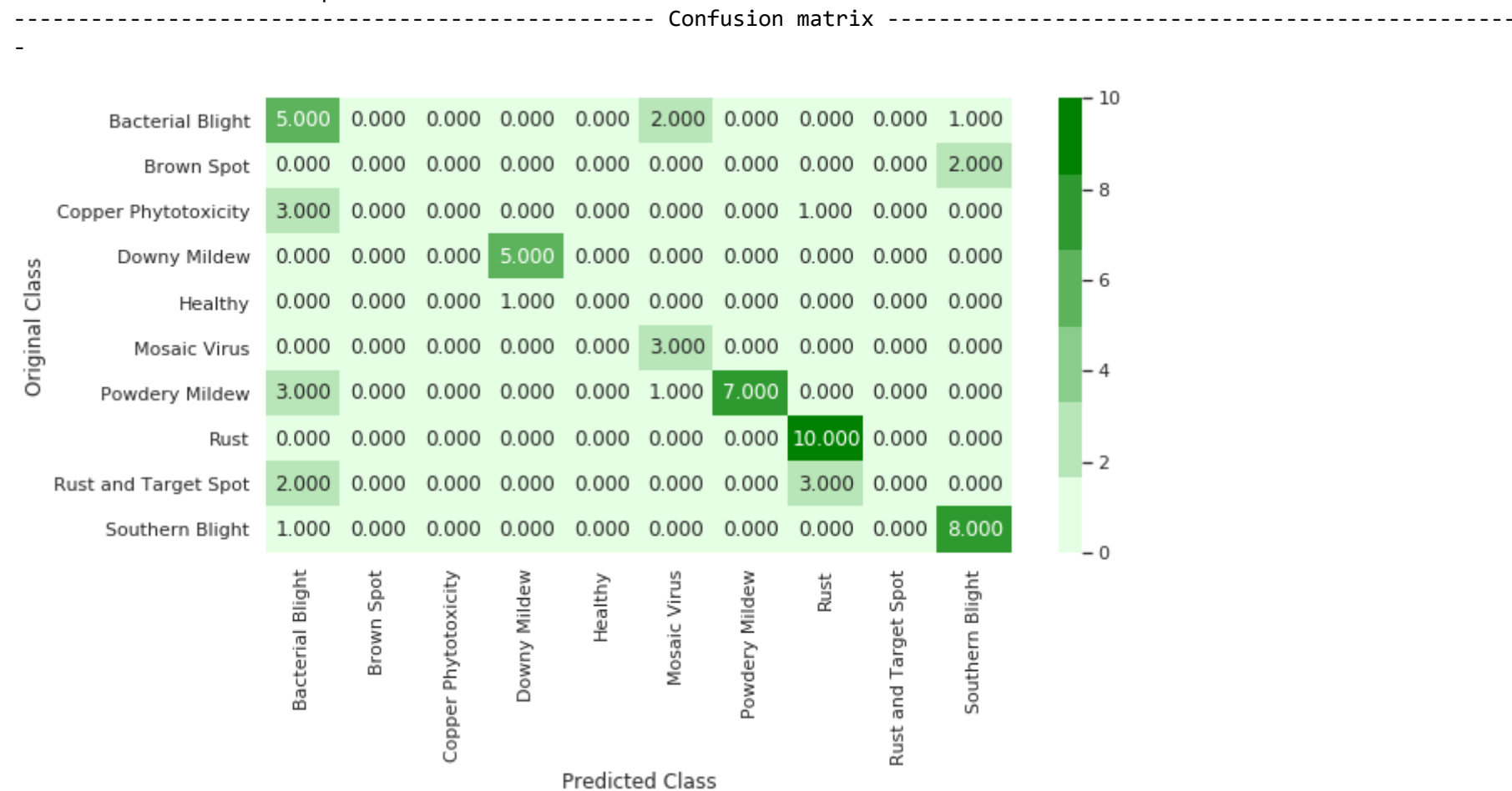
In [23]:
```
y_pred = model2.predict(X_test)

y_te2 = y_test.argmax(1)
y_pred = y_pred.argmax(1)

print("Test Accuracy: ", accuracy_score(y_te2, y_pred))
```

Test Accuracy: 0.6551724137931034

```
In [0]: plot_confusion_matrix(test_y=y_te2, predict_y=y_pred, labels=folders)
```

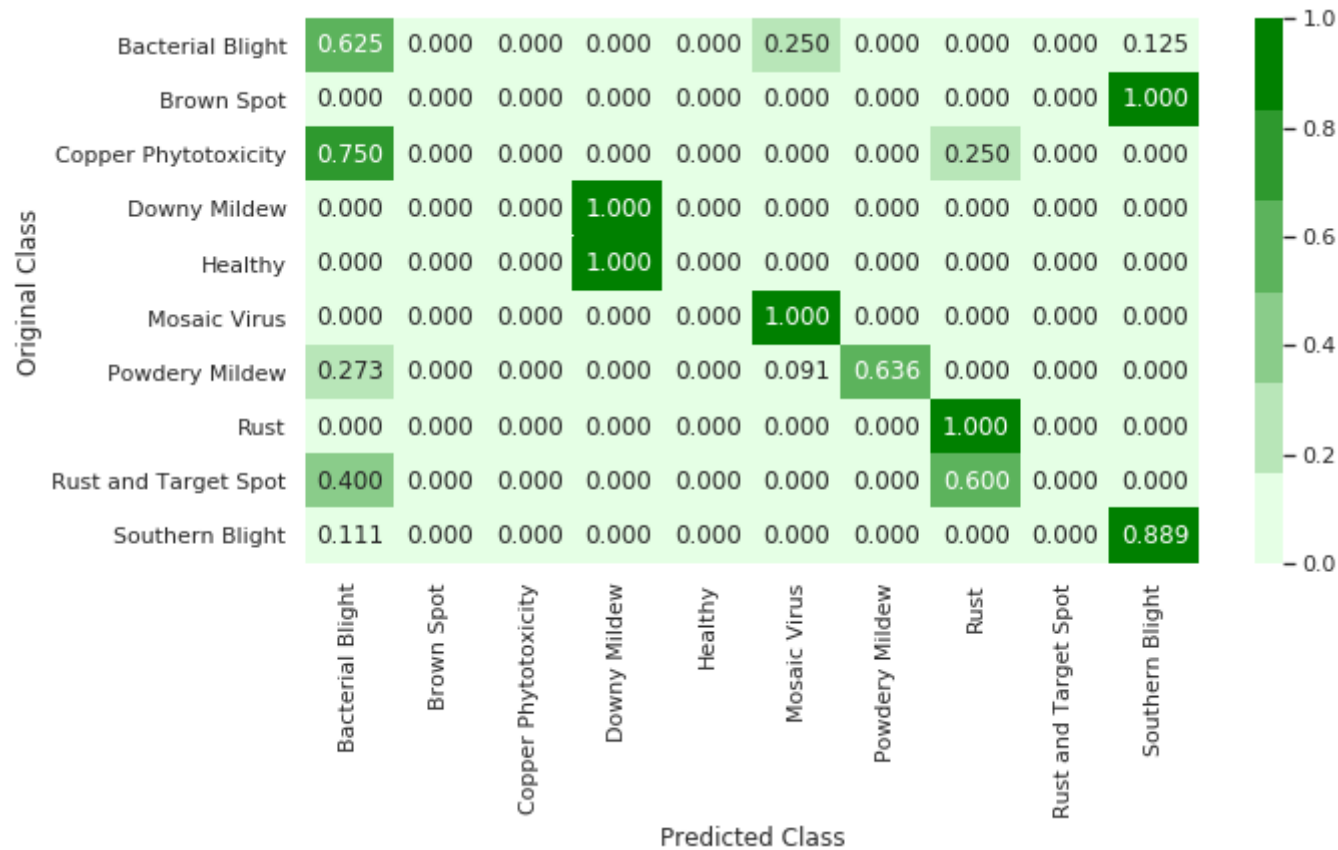Number of misclassified points 34.48275862068966
-- Confusion matrix ---
-

-- Precision matrix --
-

Sum of columns in precision matrix [1. nan nan 1. nan 1. 1. 1. nan 1.]
-- Recall matrix --

Sum of rows in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

Model 2

```
In [0]:  # Saving model weights and other important parameters
         checkpoint = ModelCheckpoint(path+"Results/Results-Cropped/model_21.h5", monitor="val_acc",
                              mode="max", save_best_only=True, verbose=1)
         tensorboard = TensorBoard(log_dir=path+'Results/Results-Cropped/graph_21', histogram_freq=4, batch_size=4,
                              update_freq='epoch')
         #reduce_lr = ReduceLROnPlateau(monitor = 'val_acc', mode="max", factor = 0.85, patience = 12, verbose = 1, min_delta =
         0.005)
         callbacks = [checkpoint, tensorboard]
```

In [25]:
```python
model = Sequential()
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', strides=(2, 2),
                 kernel_initializer='he_normal', input_shape=input_shape))
model.add(Conv2D(64, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.3))

model.add(Conv2D(128, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(Conv2D(64, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.5))
model.add(Flatten())

model.add(Dense(128, activation='relu', kernel_initializer='he_normal'))
model.add(BatchNormalization())
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu', kernel_initializer='he_normal'))
model.add(Dense(num_classes, activation='softmax'))

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

```
Model: "sequential_3"
_____
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_15 (Conv2D)           (None, 72, 72, 32)        896
_____
conv2d_16 (Conv2D)           (None, 72, 72, 64)        8256
_____
max_pooling2d_7 (MaxPooling2 (None, 36, 36, 64)        0
_____
dropout_11 (Dropout)         (None, 36, 36, 64)        0
_____
conv2d_17 (Conv2D)           (None, 36, 36, 128)       32896
_____
conv2d_18 (Conv2D)           (None, 36, 36, 64)        32832
_____
max_pooling2d_8 (MaxPooling2 (None, 18, 18, 64)        0
_____
dropout_12 (Dropout)         (None, 18, 18, 64)        0
_____
flatten_3 (Flatten)          (None, 20736)             0
_____
dense_9 (Dense)              (None, 128)               2654336
_____
batch_normalization_7 (Batch (None, 128)               512
_____
dropout_13 (Dropout)         (None, 128)               0
_____
dense_10 (Dense)             (None, 64)                8256
_____
dense_11 (Dense)             (None, 10)                650
=================================================================
Total params: 2,738,634
Trainable params: 2,738,378
Non-trainable params: 256
_____
```

```
In [0]: history = model.fit_generator(it_train, steps_per_epoch=steps,
                                epochs=300, validation_data=(X_test, y_test),
                                verbose=1, callbacks=callbacks)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (f
rom tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.
assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.
assign is deprecated. Please use tf.compat.v1.assign instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3005: The name tf.
Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:190: The name tf.g
et_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:197: The name tf.C
onfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:207: The name tf.g
lobal_variables is deprecated. Please use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:216: The name tf.i
s_variable_initialized is deprecated. Please use tf.compat.v1.is_variable_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:223: The name tf.v
ariables_initializer is deprecated. Please use tf.compat.v1.variables_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1068: The name tf.summary.histogram
is deprecated. Please use tf.compat.v1.summary.histogram instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122: The name tf.summary.merge_all
is deprecated. Please use tf.compat.v1.summary.merge_all instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125: The name tf.summary.FileWrite
r is deprecated. Please use tf.compat.v1.summary.FileWriter instead.

Epoch 1/300
157/157 [==============================] - 4s 24ms/step - loss: 2.4825 - acc: 0.1592 - val_loss: 2.8971 - val_acc: 0.
1552
```

```
Epoch 00001: val_acc improved from -inf to 0.15517, saving model to /content/drive/My Drive/Leaf Disease Classificati
on/Results/Results-Cropped/model_21.h5
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265: The name tf.Summary is deprec
ated. Please use tf.compat.v1.Summary instead.


Epoch 2/300
157/157 [==============================] - 2s 12ms/step - loss: 2.0083 - acc: 0.2787 - val_loss: 2.7851 - val_acc: 0.
1034


Epoch 00002: val_acc did not improve from 0.15517
Epoch 3/300
157/157 [==============================] - 2s 12ms/step - loss: 1.9852 - acc: 0.2659 - val_loss: 1.7167 - val_acc: 0.
2759


Epoch 00003: val_acc improved from 0.15517 to 0.27586, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 4/300
157/157 [==============================] - 2s 12ms/step - loss: 1.7510 - acc: 0.3726 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00004: val_acc did not improve from 0.27586
Epoch 5/300
157/157 [==============================] - 2s 12ms/step - loss: 1.7865 - acc: 0.3742 - val_loss: 1.4928 - val_acc: 0.
4828


Epoch 00005: val_acc improved from 0.27586 to 0.48276, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 6/300
157/157 [==============================] - 2s 12ms/step - loss: 1.7392 - acc: 0.3949 - val_loss: 4.5362 - val_acc: 0.
1207


Epoch 00006: val_acc did not improve from 0.48276
Epoch 7/300
157/157 [==============================] - 2s 11ms/step - loss: 1.7342 - acc: 0.3694 - val_loss: 1.5772 - val_acc: 0.
3793


Epoch 00007: val_acc did not improve from 0.48276
Epoch 8/300
157/157 [==============================] - 2s 12ms/step - loss: 1.6704 - acc: 0.3853 - val_loss: 1.7452 - val_acc: 0.
3276


Epoch 00008: val_acc did not improve from 0.48276
```

```
Epoch 9/300
157/157 [==============================] - 2s 12ms/step - loss: 1.5673 - acc: 0.4570 - val_loss: 1.6625 - val_acc: 0.
3621

Epoch 00009: val_acc did not improve from 0.48276
Epoch 10/300
157/157 [==============================] - 2s 12ms/step - loss: 1.5828 - acc: 0.4045 - val_loss: 2.9068 - val_acc: 0.
3103

Epoch 00010: val_acc did not improve from 0.48276
Epoch 11/300
157/157 [==============================] - 2s 11ms/step - loss: 1.6062 - acc: 0.4220 - val_loss: 1.5879 - val_acc: 0.
3793

Epoch 00011: val_acc did not improve from 0.48276
Epoch 12/300
157/157 [==============================] - 2s 12ms/step - loss: 1.4930 - acc: 0.4443 - val_loss: 1.3905 - val_acc: 0.
5172

Epoch 00012: val_acc improved from 0.48276 to 0.51724, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 13/300
157/157 [==============================] - 2s 12ms/step - loss: 1.3973 - acc: 0.5016 - val_loss: 1.5995 - val_acc: 0.
3793

Epoch 00013: val_acc did not improve from 0.51724
Epoch 14/300
157/157 [==============================] - 2s 11ms/step - loss: 1.4959 - acc: 0.4475 - val_loss: 2.2514 - val_acc: 0.
2069

Epoch 00014: val_acc did not improve from 0.51724
Epoch 15/300
157/157 [==============================] - 2s 11ms/step - loss: 1.4190 - acc: 0.4920 - val_loss: 1.9182 - val_acc: 0.
3448

Epoch 00015: val_acc did not improve from 0.51724
Epoch 16/300
157/157 [==============================] - 2s 12ms/step - loss: 1.3942 - acc: 0.4809 - val_loss: 1.3686 - val_acc: 0.
4138

Epoch 00016: val_acc did not improve from 0.51724
Epoch 17/300
```

```
157/157 [==============================] - 2s 12ms/step - loss: 1.4184 - acc: 0.4825 - val_loss: 1.1172 - val_acc: 0.
5345

Epoch 00017: val_acc improved from 0.51724 to 0.53448, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 18/300
157/157 [==============================] - 2s 11ms/step - loss: 1.3528 - acc: 0.5239 - val_loss: 1.2187 - val_acc: 0.
5690

Epoch 00018: val_acc improved from 0.53448 to 0.56897, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 19/300
157/157 [==============================] - 2s 11ms/step - loss: 1.3073 - acc: 0.5303 - val_loss: 1.9251 - val_acc: 0.
4655

Epoch 00019: val_acc did not improve from 0.56897
Epoch 20/300
157/157 [==============================] - 2s 11ms/step - loss: 1.2972 - acc: 0.5382 - val_loss: 1.0817 - val_acc: 0.
6379

Epoch 00020: val_acc improved from 0.56897 to 0.63793, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 21/300
157/157 [==============================] - 2s 12ms/step - loss: 1.2246 - acc: 0.5669 - val_loss: 1.4297 - val_acc: 0.
5000

Epoch 00021: val_acc did not improve from 0.63793
Epoch 22/300
157/157 [==============================] - 2s 11ms/step - loss: 1.2608 - acc: 0.5494 - val_loss: 1.5001 - val_acc: 0.
4483

Epoch 00022: val_acc did not improve from 0.63793
Epoch 23/300
157/157 [==============================] - 2s 13ms/step - loss: 1.1987 - acc: 0.5780 - val_loss: 1.2387 - val_acc: 0.
5862

Epoch 00023: val_acc did not improve from 0.63793
Epoch 24/300
157/157 [==============================] - 2s 11ms/step - loss: 1.1357 - acc: 0.6003 - val_loss: 1.0275 - val_acc: 0.
6552

Epoch 00024: val_acc improved from 0.63793 to 0.65517, saving model to /content/drive/My Drive/Leaf Disease Classific
```

```
ation/Results/Results-Cropped/model_21.h5
Epoch 25/300
157/157 [==============================] - 2s 13ms/step - loss: 1.2275 - acc: 0.5701 - val_loss: 1.1753 - val_acc: 0.
6724

Epoch 00025: val_acc improved from 0.65517 to 0.67241, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 26/300
157/157 [==============================] - 2s 11ms/step - loss: 1.1627 - acc: 0.6003 - val_loss: 1.0275 - val_acc: 0.
6724

Epoch 00026: val_acc did not improve from 0.67241
Epoch 27/300
157/157 [==============================] - 2s 11ms/step - loss: 1.1894 - acc: 0.5621 - val_loss: 1.2238 - val_acc: 0.
5517

Epoch 00027: val_acc did not improve from 0.67241
Epoch 28/300
157/157 [==============================] - 2s 12ms/step - loss: 1.0567 - acc: 0.6051 - val_loss: 1.1259 - val_acc: 0.
5690

Epoch 00028: val_acc did not improve from 0.67241
Epoch 29/300
157/157 [==============================] - 2s 12ms/step - loss: 1.1263 - acc: 0.6051 - val_loss: 0.9478 - val_acc: 0.
6552

Epoch 00029: val_acc did not improve from 0.67241
Epoch 30/300
157/157 [==============================] - 2s 11ms/step - loss: 1.2471 - acc: 0.5557 - val_loss: 1.0816 - val_acc: 0.
6552

Epoch 00030: val_acc did not improve from 0.67241
Epoch 31/300
157/157 [==============================] - 2s 11ms/step - loss: 1.1225 - acc: 0.6369 - val_loss: 0.8526 - val_acc: 0.
6724

Epoch 00031: val_acc did not improve from 0.67241
Epoch 32/300
157/157 [==============================] - 2s 12ms/step - loss: 1.0760 - acc: 0.6497 - val_loss: 0.9569 - val_acc: 0.
6552

Epoch 00032: val_acc did not improve from 0.67241
```

```
Epoch 33/300
157/157 [==============================] - 2s 12ms/step - loss: 1.1209 - acc: 0.6258 - val_loss: 0.7112 - val_acc: 0.
7586

Epoch 00033: val_acc improved from 0.67241 to 0.75862, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 34/300
157/157 [==============================] - 2s 12ms/step - loss: 0.9912 - acc: 0.6592 - val_loss: 1.1874 - val_acc: 0.
5345

Epoch 00034: val_acc did not improve from 0.75862
Epoch 35/300
157/157 [==============================] - 2s 12ms/step - loss: 1.1300 - acc: 0.6258 - val_loss: 1.1286 - val_acc: 0.
6207

Epoch 00035: val_acc did not improve from 0.75862
Epoch 36/300
157/157 [==============================] - 2s 13ms/step - loss: 0.8968 - acc: 0.7166 - val_loss: 1.0031 - val_acc: 0.
6034

Epoch 00036: val_acc did not improve from 0.75862
Epoch 37/300
157/157 [==============================] - 2s 11ms/step - loss: 1.0251 - acc: 0.6688 - val_loss: 0.8827 - val_acc: 0.
6897

Epoch 00037: val_acc did not improve from 0.75862
Epoch 38/300
157/157 [==============================] - 2s 12ms/step - loss: 1.0125 - acc: 0.6561 - val_loss: 1.1427 - val_acc: 0.
6379

Epoch 00038: val_acc did not improve from 0.75862
Epoch 39/300
157/157 [==============================] - 2s 11ms/step - loss: 1.0924 - acc: 0.6258 - val_loss: 0.7777 - val_acc: 0.
7241

Epoch 00039: val_acc did not improve from 0.75862
Epoch 40/300
157/157 [==============================] - 2s 12ms/step - loss: 1.0232 - acc: 0.6608 - val_loss: 0.9390 - val_acc: 0.
6552

Epoch 00040: val_acc did not improve from 0.75862
Epoch 41/300
```

```
157/157 [==============================] - 2s 12ms/step - loss: 0.9252 - acc: 0.6704 - val_loss: 1.3697 - val_acc: 0.
5690

Epoch 00041: val_acc did not improve from 0.75862
Epoch 42/300
157/157 [==============================] - 2s 11ms/step - loss: 0.9170 - acc: 0.6704 - val_loss: 1.1149 - val_acc: 0.
6724

Epoch 00042: val_acc did not improve from 0.75862
Epoch 43/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8274 - acc: 0.7261 - val_loss: 0.8485 - val_acc: 0.
6724

Epoch 00043: val_acc did not improve from 0.75862
Epoch 44/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8958 - acc: 0.7038 - val_loss: 0.6877 - val_acc: 0.
7069

Epoch 00044: val_acc did not improve from 0.75862
Epoch 45/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8668 - acc: 0.6927 - val_loss: 1.5297 - val_acc: 0.
5172

Epoch 00045: val_acc did not improve from 0.75862
Epoch 46/300
157/157 [==============================] - 2s 13ms/step - loss: 0.9601 - acc: 0.6943 - val_loss: 1.0116 - val_acc: 0.
6724

Epoch 00046: val_acc did not improve from 0.75862
Epoch 47/300
157/157 [==============================] - 2s 13ms/step - loss: 0.9439 - acc: 0.6990 - val_loss: 0.6871 - val_acc: 0.
7241

Epoch 00047: val_acc did not improve from 0.75862
Epoch 48/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8290 - acc: 0.7293 - val_loss: 0.9097 - val_acc: 0.
7241

Epoch 00048: val_acc did not improve from 0.75862
Epoch 49/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8928 - acc: 0.7229 - val_loss: 1.2348 - val_acc: 0.
6207
```

```
Epoch 00049: val_acc did not improve from 0.75862
Epoch 50/300
157/157 [==============================] - 2s 11ms/step - loss: 0.9935 - acc: 0.6847 - val_loss: 0.8173 - val_acc: 0.
7069

Epoch 00050: val_acc did not improve from 0.75862
Epoch 51/300
157/157 [==============================] - 2s 11ms/step - loss: 0.9314 - acc: 0.6847 - val_loss: 1.4549 - val_acc: 0.
5517

Epoch 00051: val_acc did not improve from 0.75862
Epoch 52/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8124 - acc: 0.7277 - val_loss: 0.9672 - val_acc: 0.
6379

Epoch 00052: val_acc did not improve from 0.75862
Epoch 53/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8220 - acc: 0.7373 - val_loss: 0.9779 - val_acc: 0.
7414

Epoch 00053: val_acc did not improve from 0.75862
Epoch 54/300
157/157 [==============================] - 2s 11ms/step - loss: 0.9254 - acc: 0.7166 - val_loss: 0.8250 - val_acc: 0.
7586

Epoch 00054: val_acc did not improve from 0.75862
Epoch 55/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8199 - acc: 0.7293 - val_loss: 1.0471 - val_acc: 0.
6379

Epoch 00055: val_acc did not improve from 0.75862
Epoch 56/300
157/157 [==============================] - 2s 12ms/step - loss: 0.9392 - acc: 0.6927 - val_loss: 1.3429 - val_acc: 0.
5862

Epoch 00056: val_acc did not improve from 0.75862
Epoch 57/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8719 - acc: 0.7118 - val_loss: 1.2197 - val_acc: 0.
6207

Epoch 00057: val_acc did not improve from 0.75862
```

```
Epoch 58/300
157/157 [==============================] - 2s 13ms/step - loss: 0.8215 - acc: 0.7325 - val_loss: 0.7664 - val_acc: 0.
7241

Epoch 00058: val_acc did not improve from 0.75862
Epoch 59/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8353 - acc: 0.7166 - val_loss: 0.9397 - val_acc: 0.
7414

Epoch 00059: val_acc did not improve from 0.75862
Epoch 60/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8565 - acc: 0.7309 - val_loss: 1.3586 - val_acc: 0.
5862

Epoch 00060: val_acc did not improve from 0.75862
Epoch 61/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7150 - acc: 0.7691 - val_loss: 1.2688 - val_acc: 0.
6034

Epoch 00061: val_acc did not improve from 0.75862
Epoch 62/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7957 - acc: 0.7388 - val_loss: 2.3708 - val_acc: 0.
5517

Epoch 00062: val_acc did not improve from 0.75862
Epoch 63/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6487 - acc: 0.7691 - val_loss: 0.9532 - val_acc: 0.
7241

Epoch 00063: val_acc did not improve from 0.75862
Epoch 64/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7927 - acc: 0.7627 - val_loss: 1.0429 - val_acc: 0.
6379

Epoch 00064: val_acc did not improve from 0.75862
Epoch 65/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7655 - acc: 0.7596 - val_loss: 1.0754 - val_acc: 0.
6897

Epoch 00065: val_acc did not improve from 0.75862
Epoch 66/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8356 - acc: 0.7548 - val_loss: 1.3356 - val_acc: 0.
```

5690

Epoch 00066: val_acc did not improve from 0.75862
Epoch 67/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8197 - acc: 0.7293 - val_loss: 0.7872 - val_acc: 0.7586

Epoch 00067: val_acc did not improve from 0.75862
Epoch 68/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8365 - acc: 0.7261 - val_loss: 0.8966 - val_acc: 0.7414

Epoch 00068: val_acc did not improve from 0.75862
Epoch 69/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8233 - acc: 0.7420 - val_loss: 1.0625 - val_acc: 0.6379

Epoch 00069: val_acc did not improve from 0.75862
Epoch 70/300
157/157 [==============================] - 2s 11ms/step - loss: 0.7360 - acc: 0.7707 - val_loss: 0.9123 - val_acc: 0.7069

Epoch 00070: val_acc did not improve from 0.75862
Epoch 71/300
157/157 [==============================] - 2s 11ms/step - loss: 0.8482 - acc: 0.7421 - val_loss: 1.1952 - val_acc: 0.6552

Epoch 00071: val_acc did not improve from 0.75862
Epoch 72/300
157/157 [==============================] - 2s 11ms/step - loss: 0.7633 - acc: 0.7452 - val_loss: 0.9486 - val_acc: 0.6379

Epoch 00072: val_acc did not improve from 0.75862
Epoch 73/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6528 - acc: 0.7771 - val_loss: 1.1803 - val_acc: 0.6207

Epoch 00073: val_acc did not improve from 0.75862
Epoch 74/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6927 - acc: 0.7771 - val_loss: 0.8502 - val_acc: 0.7241

```
Epoch 00074: val_acc did not improve from 0.75862
Epoch 75/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7244 - acc: 0.7675 - val_loss: 1.1401 - val_acc: 0.
7414

Epoch 00075: val_acc did not improve from 0.75862
Epoch 76/300
157/157 [==============================] - 2s 12ms/step - loss: 0.8698 - acc: 0.7452 - val_loss: 1.1314 - val_acc: 0.
6034

Epoch 00076: val_acc did not improve from 0.75862
Epoch 77/300
157/157 [==============================] - 2s 11ms/step - loss: 0.7380 - acc: 0.7293 - val_loss: 2.9678 - val_acc: 0.
3103

Epoch 00077: val_acc did not improve from 0.75862
Epoch 78/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6885 - acc: 0.7819 - val_loss: 0.7814 - val_acc: 0.
7414

Epoch 00078: val_acc did not improve from 0.75862
Epoch 79/300
157/157 [==============================] - 2s 11ms/step - loss: 0.7371 - acc: 0.7611 - val_loss: 0.8676 - val_acc: 0.
6724

Epoch 00079: val_acc did not improve from 0.75862
Epoch 80/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7520 - acc: 0.7707 - val_loss: 1.0898 - val_acc: 0.
6207

Epoch 00080: val_acc did not improve from 0.75862
Epoch 81/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6559 - acc: 0.7850 - val_loss: 0.9817 - val_acc: 0.
6724

Epoch 00081: val_acc did not improve from 0.75862
Epoch 82/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6520 - acc: 0.7962 - val_loss: 0.9139 - val_acc: 0.
7414

Epoch 00082: val_acc did not improve from 0.75862
Epoch 83/300
```

```
157/157 [==============================] - 2s 11ms/step - loss: 0.6775 - acc: 0.7787 - val_loss: 0.7298 - val_acc: 0.
7931

Epoch 00083: val_acc improved from 0.75862 to 0.79310, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 84/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7467 - acc: 0.7755 - val_loss: 1.2349 - val_acc: 0.
6724

Epoch 00084: val_acc did not improve from 0.79310
Epoch 85/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6785 - acc: 0.7850 - val_loss: 1.0628 - val_acc: 0.
6897

Epoch 00085: val_acc did not improve from 0.79310
Epoch 86/300
157/157 [==============================] - 2s 13ms/step - loss: 0.6693 - acc: 0.7914 - val_loss: 1.3179 - val_acc: 0.
6207

Epoch 00086: val_acc did not improve from 0.79310
Epoch 87/300
157/157 [==============================] - 2s 11ms/step - loss: 0.7107 - acc: 0.7803 - val_loss: 1.0671 - val_acc: 0.
6379

Epoch 00087: val_acc did not improve from 0.79310
Epoch 88/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7316 - acc: 0.7850 - val_loss: 2.3055 - val_acc: 0.
3793

Epoch 00088: val_acc did not improve from 0.79310
Epoch 89/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6035 - acc: 0.8169 - val_loss: 1.1633 - val_acc: 0.
6724

Epoch 00089: val_acc did not improve from 0.79310
Epoch 90/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6918 - acc: 0.7787 - val_loss: 1.1627 - val_acc: 0.
6379

Epoch 00090: val_acc did not improve from 0.79310
Epoch 91/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6201 - acc: 0.8153 - val_loss: 0.8192 - val_acc: 0.
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        7759

        Epoch 00091: val_acc did not improve from 0.79310
        Epoch 92/300
        157/157 [==============================] - 2s 13ms/step - loss: 0.6980 - acc: 0.7803 - val_loss: 1.2687 - val_acc: 0.
        6379

        Epoch 00092: val_acc did not improve from 0.79310
        Epoch 93/300
        157/157 [==============================] - 2s 12ms/step - loss: 0.6438 - acc: 0.7978 - val_loss: 1.0662 - val_acc: 0.
        7414

        Epoch 00093: val_acc did not improve from 0.79310
        Epoch 94/300
        157/157 [==============================] - 2s 11ms/step - loss: 0.6141 - acc: 0.8105 - val_loss: 0.8493 - val_acc: 0.
        7586

        Epoch 00094: val_acc did not improve from 0.79310
        Epoch 95/300
        157/157 [==============================] - 2s 11ms/step - loss: 0.6712 - acc: 0.7850 - val_loss: 1.2219 - val_acc: 0.
        6552

        Epoch 00095: val_acc did not improve from 0.79310
        Epoch 96/300
        157/157 [==============================] - 2s 11ms/step - loss: 0.6277 - acc: 0.7946 - val_loss: 1.2699 - val_acc: 0.
        6724

        Epoch 00096: val_acc did not improve from 0.79310
        Epoch 97/300
        157/157 [==============================] - 2s 11ms/step - loss: 0.6585 - acc: 0.8105 - val_loss: 1.2880 - val_acc: 0.
        6207

        Epoch 00097: val_acc did not improve from 0.79310
        Epoch 98/300
        157/157 [==============================] - 2s 11ms/step - loss: 0.7435 - acc: 0.7675 - val_loss: 0.9992 - val_acc: 0.
        7414

        Epoch 00098: val_acc did not improve from 0.79310
        Epoch 99/300
        157/157 [==============================] - 2s 11ms/step - loss: 0.6217 - acc: 0.8025 - val_loss: 0.9029 - val_acc: 0.
        7759
```

```
Epoch 00099: val_acc did not improve from 0.79310
Epoch 100/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5800 - acc: 0.8073 - val_loss: 1.1155 - val_acc: 0.
6724

Epoch 00100: val_acc did not improve from 0.79310
Epoch 101/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5715 - acc: 0.8344 - val_loss: 1.6973 - val_acc: 0.
5690

Epoch 00101: val_acc did not improve from 0.79310
Epoch 102/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6326 - acc: 0.8026 - val_loss: 0.9975 - val_acc: 0.
7241

Epoch 00102: val_acc did not improve from 0.79310
Epoch 103/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6500 - acc: 0.8026 - val_loss: 1.7742 - val_acc: 0.
5862

Epoch 00103: val_acc did not improve from 0.79310
Epoch 104/300
157/157 [==============================] - 2s 13ms/step - loss: 0.7145 - acc: 0.7818 - val_loss: 0.7409 - val_acc: 0.
7241

Epoch 00104: val_acc did not improve from 0.79310
Epoch 105/300
157/157 [==============================] - 2s 12ms/step - loss: 0.7003 - acc: 0.8042 - val_loss: 1.6148 - val_acc: 0.
6724

Epoch 00105: val_acc did not improve from 0.79310
Epoch 106/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6817 - acc: 0.8041 - val_loss: 1.0192 - val_acc: 0.
6897

Epoch 00106: val_acc did not improve from 0.79310
Epoch 107/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6121 - acc: 0.8025 - val_loss: 1.1899 - val_acc: 0.
6207

Epoch 00107: val_acc did not improve from 0.79310
Epoch 108/300
```

```
157/157 [==============================] - 2s 12ms/step - loss: 0.5884 - acc: 0.8089 - val_loss: 1.3338 - val_acc: 0.
6379

Epoch 00108: val_acc did not improve from 0.79310
Epoch 109/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6901 - acc: 0.7946 - val_loss: 0.8752 - val_acc: 0.
7414

Epoch 00109: val_acc did not improve from 0.79310
Epoch 110/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6730 - acc: 0.7994 - val_loss: 1.3730 - val_acc: 0.
7069

Epoch 00110: val_acc did not improve from 0.79310
Epoch 111/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6694 - acc: 0.7978 - val_loss: 1.2099 - val_acc: 0.
6207

Epoch 00111: val_acc did not improve from 0.79310
Epoch 112/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5100 - acc: 0.8360 - val_loss: 1.4535 - val_acc: 0.
6379

Epoch 00112: val_acc did not improve from 0.79310
Epoch 113/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4876 - acc: 0.8455 - val_loss: 2.3632 - val_acc: 0.
5172

Epoch 00113: val_acc did not improve from 0.79310
Epoch 114/300
157/157 [==============================] - 2s 11ms/step - loss: 0.7125 - acc: 0.8137 - val_loss: 1.3193 - val_acc: 0.
6379

Epoch 00114: val_acc did not improve from 0.79310
Epoch 115/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5815 - acc: 0.8312 - val_loss: 0.9423 - val_acc: 0.
7069

Epoch 00115: val_acc did not improve from 0.79310
Epoch 116/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6119 - acc: 0.8025 - val_loss: 1.0003 - val_acc: 0.
6897
```

```
Epoch 00116: val_acc did not improve from 0.79310
Epoch 117/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6092 - acc: 0.8201 - val_loss: 1.0021 - val_acc: 0.
6207

Epoch 00117: val_acc did not improve from 0.79310
Epoch 118/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6166 - acc: 0.7978 - val_loss: 1.0732 - val_acc: 0.
6552

Epoch 00118: val_acc did not improve from 0.79310
Epoch 119/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6236 - acc: 0.8248 - val_loss: 0.8822 - val_acc: 0.
7414

Epoch 00119: val_acc did not improve from 0.79310
Epoch 120/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4539 - acc: 0.8551 - val_loss: 0.8591 - val_acc: 0.
7241

Epoch 00120: val_acc did not improve from 0.79310
Epoch 121/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6113 - acc: 0.8471 - val_loss: 0.8214 - val_acc: 0.
7414

Epoch 00121: val_acc did not improve from 0.79310
Epoch 122/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5667 - acc: 0.8121 - val_loss: 0.8366 - val_acc: 0.
7241

Epoch 00122: val_acc did not improve from 0.79310
Epoch 123/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6090 - acc: 0.8201 - val_loss: 0.8563 - val_acc: 0.
7586

Epoch 00123: val_acc did not improve from 0.79310
Epoch 124/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6703 - acc: 0.8153 - val_loss: 1.4750 - val_acc: 0.
5172

Epoch 00124: val_acc did not improve from 0.79310
```

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Epoch 125/300
157/157 [==============================] - 2s 11ms/step - loss: 0.7206 - acc: 0.7866 - val_loss: 1.0397 - val_acc: 0.
7069

Epoch 00125: val_acc did not improve from 0.79310
Epoch 126/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4713 - acc: 0.8360 - val_loss: 1.2689 - val_acc: 0.
7069

Epoch 00126: val_acc did not improve from 0.79310
Epoch 127/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5951 - acc: 0.8360 - val_loss: 0.8774 - val_acc: 0.
7931

Epoch 00127: val_acc did not improve from 0.79310
Epoch 128/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5907 - acc: 0.8296 - val_loss: 0.8541 - val_acc: 0.
7414

Epoch 00128: val_acc did not improve from 0.79310
Epoch 129/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5633 - acc: 0.8201 - val_loss: 1.1612 - val_acc: 0.
6034

Epoch 00129: val_acc did not improve from 0.79310
Epoch 130/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5735 - acc: 0.8153 - val_loss: 1.0872 - val_acc: 0.
7069

Epoch 00130: val_acc did not improve from 0.79310
Epoch 131/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5176 - acc: 0.8392 - val_loss: 1.1694 - val_acc: 0.
6897

Epoch 00131: val_acc did not improve from 0.79310
Epoch 132/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5426 - acc: 0.8471 - val_loss: 1.0416 - val_acc: 0.
7586

Epoch 00132: val_acc did not improve from 0.79310
Epoch 133/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5556 - acc: 0.8376 - val_loss: 0.9579 - val_acc: 0.
```

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7586

Epoch 00133: val_acc did not improve from 0.79310
Epoch 134/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5567 - acc: 0.8360 - val_loss: 1.2385 - val_acc: 0.
6207

Epoch 00134: val_acc did not improve from 0.79310
Epoch 135/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5652 - acc: 0.8233 - val_loss: 0.9149 - val_acc: 0.
7241

Epoch 00135: val_acc did not improve from 0.79310
Epoch 136/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4848 - acc: 0.8567 - val_loss: 1.0660 - val_acc: 0.
6897

Epoch 00136: val_acc did not improve from 0.79310
Epoch 137/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4908 - acc: 0.8503 - val_loss: 0.8207 - val_acc: 0.
7759

Epoch 00137: val_acc did not improve from 0.79310
Epoch 138/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5476 - acc: 0.8439 - val_loss: 1.0893 - val_acc: 0.
7241

Epoch 00138: val_acc did not improve from 0.79310
Epoch 139/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5964 - acc: 0.8105 - val_loss: 0.8968 - val_acc: 0.
7759

Epoch 00139: val_acc did not improve from 0.79310
Epoch 140/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6284 - acc: 0.8105 - val_loss: 0.7924 - val_acc: 0.
7414

Epoch 00140: val_acc did not improve from 0.79310
Epoch 141/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6336 - acc: 0.8105 - val_loss: 1.2283 - val_acc: 0.
7069
```

```
Epoch 00141: val_acc did not improve from 0.79310
Epoch 142/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5670 - acc: 0.8280 - val_loss: 0.7946 - val_acc: 0.
7759


Epoch 00142: val_acc did not improve from 0.79310
Epoch 143/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5424 - acc: 0.8344 - val_loss: 1.0548 - val_acc: 0.
7241


Epoch 00143: val_acc did not improve from 0.79310
Epoch 144/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5597 - acc: 0.8153 - val_loss: 0.8733 - val_acc: 0.
7586


Epoch 00144: val_acc did not improve from 0.79310
Epoch 145/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5322 - acc: 0.8408 - val_loss: 0.9832 - val_acc: 0.
7241


Epoch 00145: val_acc did not improve from 0.79310
Epoch 146/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6442 - acc: 0.8201 - val_loss: 0.8903 - val_acc: 0.
7069


Epoch 00146: val_acc did not improve from 0.79310
Epoch 147/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4690 - acc: 0.8599 - val_loss: 1.6456 - val_acc: 0.
6034


Epoch 00147: val_acc did not improve from 0.79310
Epoch 148/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5889 - acc: 0.8264 - val_loss: 0.8863 - val_acc: 0.
7241


Epoch 00148: val_acc did not improve from 0.79310
Epoch 149/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6205 - acc: 0.8248 - val_loss: 0.8645 - val_acc: 0.
7586


Epoch 00149: val_acc did not improve from 0.79310
Epoch 150/300
```

```
157/157 [==============================] - 2s 12ms/step - loss: 0.5388 - acc: 0.8503 - val_loss: 0.9576 - val_acc: 0.
6552

Epoch 00150: val_acc did not improve from 0.79310
Epoch 151/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5839 - acc: 0.8280 - val_loss: 1.0378 - val_acc: 0.
7586

Epoch 00151: val_acc did not improve from 0.79310
Epoch 152/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5484 - acc: 0.8280 - val_loss: 1.4901 - val_acc: 0.
5345

Epoch 00152: val_acc did not improve from 0.79310
Epoch 153/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6464 - acc: 0.8153 - val_loss: 1.0005 - val_acc: 0.
6724

Epoch 00153: val_acc did not improve from 0.79310
Epoch 154/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5935 - acc: 0.8280 - val_loss: 0.8000 - val_acc: 0.
7241

Epoch 00154: val_acc did not improve from 0.79310
Epoch 155/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4866 - acc: 0.8471 - val_loss: 1.1789 - val_acc: 0.
7241

Epoch 00155: val_acc did not improve from 0.79310
Epoch 156/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4498 - acc: 0.8519 - val_loss: 2.1643 - val_acc: 0.
4828

Epoch 00156: val_acc did not improve from 0.79310
Epoch 157/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4904 - acc: 0.8615 - val_loss: 1.0024 - val_acc: 0.
7414

Epoch 00157: val_acc did not improve from 0.79310
Epoch 158/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5379 - acc: 0.8248 - val_loss: 1.8042 - val_acc: 0.
6034
```

```
Epoch 00158: val_acc did not improve from 0.79310
Epoch 159/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4449 - acc: 0.8392 - val_loss: 1.0139 - val_acc: 0.
7241


Epoch 00159: val_acc did not improve from 0.79310
Epoch 160/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6271 - acc: 0.8471 - val_loss: 1.2490 - val_acc: 0.
6724


Epoch 00160: val_acc did not improve from 0.79310
Epoch 161/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5288 - acc: 0.8551 - val_loss: 0.9885 - val_acc: 0.
6724


Epoch 00161: val_acc did not improve from 0.79310
Epoch 162/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4850 - acc: 0.8631 - val_loss: 1.3419 - val_acc: 0.
6379


Epoch 00162: val_acc did not improve from 0.79310
Epoch 163/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4355 - acc: 0.8599 - val_loss: 1.0009 - val_acc: 0.
7069


Epoch 00163: val_acc did not improve from 0.79310
Epoch 164/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5374 - acc: 0.8455 - val_loss: 0.9556 - val_acc: 0.
6552


Epoch 00164: val_acc did not improve from 0.79310
Epoch 165/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4658 - acc: 0.8583 - val_loss: 0.9311 - val_acc: 0.
7414


Epoch 00165: val_acc did not improve from 0.79310
Epoch 166/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4704 - acc: 0.8806 - val_loss: 1.5637 - val_acc: 0.
6724


Epoch 00166: val_acc did not improve from 0.79310
```

```
Epoch 167/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6089 - acc: 0.8328 - val_loss: 0.6463 - val_acc: 0.
7586

Epoch 00167: val_acc did not improve from 0.79310
Epoch 168/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6109 - acc: 0.8487 - val_loss: 0.8825 - val_acc: 0.
7241

Epoch 00168: val_acc did not improve from 0.79310
Epoch 169/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6007 - acc: 0.8503 - val_loss: 1.0279 - val_acc: 0.
7069

Epoch 00169: val_acc did not improve from 0.79310
Epoch 170/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4855 - acc: 0.8710 - val_loss: 0.9970 - val_acc: 0.
7241

Epoch 00170: val_acc did not improve from 0.79310
Epoch 171/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5829 - acc: 0.8440 - val_loss: 1.0526 - val_acc: 0.
6379

Epoch 00171: val_acc did not improve from 0.79310
Epoch 172/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4032 - acc: 0.8758 - val_loss: 1.1796 - val_acc: 0.
6552

Epoch 00172: val_acc did not improve from 0.79310
Epoch 173/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4502 - acc: 0.8806 - val_loss: 1.0433 - val_acc: 0.
7241

Epoch 00173: val_acc did not improve from 0.79310
Epoch 174/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5056 - acc: 0.8487 - val_loss: 1.8576 - val_acc: 0.
6552

Epoch 00174: val_acc did not improve from 0.79310
Epoch 175/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5439 - acc: 0.8551 - val_loss: 1.7661 - val_acc: 0.
```

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5690

Epoch 00175: val_acc did not improve from 0.79310
Epoch 176/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5176 - acc: 0.8583 - val_loss: 1.1400 - val_acc: 0.
7069

Epoch 00176: val_acc did not improve from 0.79310
Epoch 177/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4119 - acc: 0.8901 - val_loss: 1.5473 - val_acc: 0.
6379

Epoch 00177: val_acc did not improve from 0.79310
Epoch 178/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4191 - acc: 0.8885 - val_loss: 1.0788 - val_acc: 0.
6897

Epoch 00178: val_acc did not improve from 0.79310
Epoch 179/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5740 - acc: 0.8487 - val_loss: 0.9959 - val_acc: 0.
7759

Epoch 00179: val_acc did not improve from 0.79310
Epoch 180/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4838 - acc: 0.8631 - val_loss: 2.0305 - val_acc: 0.
6034

Epoch 00180: val_acc did not improve from 0.79310
Epoch 181/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4931 - acc: 0.8662 - val_loss: 0.9658 - val_acc: 0.
7586

Epoch 00181: val_acc did not improve from 0.79310
Epoch 182/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4660 - acc: 0.8758 - val_loss: 1.3319 - val_acc: 0.
6897

Epoch 00182: val_acc did not improve from 0.79310
Epoch 183/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4703 - acc: 0.8758 - val_loss: 1.1752 - val_acc: 0.
7069
```

```
Epoch 00183: val_acc did not improve from 0.79310
Epoch 184/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4864 - acc: 0.8710 - val_loss: 0.9584 - val_acc: 0.
7759


Epoch 00184: val_acc did not improve from 0.79310
Epoch 185/300
157/157 [==============================] - 2s 13ms/step - loss: 0.5820 - acc: 0.8440 - val_loss: 1.3599 - val_acc: 0.
6724


Epoch 00185: val_acc did not improve from 0.79310
Epoch 186/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4906 - acc: 0.8472 - val_loss: 1.3208 - val_acc: 0.
6552


Epoch 00186: val_acc did not improve from 0.79310
Epoch 187/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5977 - acc: 0.8440 - val_loss: 2.5800 - val_acc: 0.
4138


Epoch 00187: val_acc did not improve from 0.79310
Epoch 188/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5654 - acc: 0.8264 - val_loss: 1.0980 - val_acc: 0.
7069


Epoch 00188: val_acc did not improve from 0.79310
Epoch 189/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4750 - acc: 0.8694 - val_loss: 1.1946 - val_acc: 0.
7069


Epoch 00189: val_acc did not improve from 0.79310
Epoch 190/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5592 - acc: 0.8551 - val_loss: 0.7986 - val_acc: 0.
7931


Epoch 00190: val_acc did not improve from 0.79310
Epoch 191/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5583 - acc: 0.8519 - val_loss: 1.3383 - val_acc: 0.
6552


Epoch 00191: val_acc did not improve from 0.79310
Epoch 192/300
```

```
157/157 [==============================] - 2s 11ms/step - loss: 0.4688 - acc: 0.8567 - val_loss: 1.4742 - val_acc: 0.
6379

Epoch 00192: val_acc did not improve from 0.79310
Epoch 193/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5205 - acc: 0.8567 - val_loss: 1.0457 - val_acc: 0.
6897

Epoch 00193: val_acc did not improve from 0.79310
Epoch 194/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3476 - acc: 0.9076 - val_loss: 1.0835 - val_acc: 0.
7931

Epoch 00194: val_acc did not improve from 0.79310
Epoch 195/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4021 - acc: 0.8806 - val_loss: 0.9721 - val_acc: 0.
7414

Epoch 00195: val_acc did not improve from 0.79310
Epoch 196/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5431 - acc: 0.8408 - val_loss: 0.9784 - val_acc: 0.
7414

Epoch 00196: val_acc did not improve from 0.79310
Epoch 197/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4620 - acc: 0.8583 - val_loss: 1.3366 - val_acc: 0.
6379

Epoch 00197: val_acc did not improve from 0.79310
Epoch 198/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5348 - acc: 0.8503 - val_loss: 1.3729 - val_acc: 0.
7241

Epoch 00198: val_acc did not improve from 0.79310
Epoch 199/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5134 - acc: 0.8472 - val_loss: 1.0886 - val_acc: 0.
6897

Epoch 00199: val_acc did not improve from 0.79310
Epoch 200/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5900 - acc: 0.8440 - val_loss: 0.9552 - val_acc: 0.
7931
```

```
Epoch 00200: val_acc did not improve from 0.79310
Epoch 201/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4874 - acc: 0.8647 - val_loss: 2.4158 - val_acc: 0.
4310

Epoch 00201: val_acc did not improve from 0.79310
Epoch 202/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4970 - acc: 0.8567 - val_loss: 2.0040 - val_acc: 0.
5517

Epoch 00202: val_acc did not improve from 0.79310
Epoch 203/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4487 - acc: 0.8806 - val_loss: 1.1684 - val_acc: 0.
7241

Epoch 00203: val_acc did not improve from 0.79310
Epoch 204/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4966 - acc: 0.8471 - val_loss: 1.0512 - val_acc: 0.
6897

Epoch 00204: val_acc did not improve from 0.79310
Epoch 205/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4693 - acc: 0.8535 - val_loss: 0.9559 - val_acc: 0.
7069

Epoch 00205: val_acc did not improve from 0.79310
Epoch 206/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4783 - acc: 0.8583 - val_loss: 1.3846 - val_acc: 0.
6724

Epoch 00206: val_acc did not improve from 0.79310
Epoch 207/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5046 - acc: 0.8615 - val_loss: 1.0060 - val_acc: 0.
7241

Epoch 00207: val_acc did not improve from 0.79310
Epoch 208/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4650 - acc: 0.8790 - val_loss: 0.9346 - val_acc: 0.
7414

Epoch 00208: val_acc did not improve from 0.79310
```

```
Epoch 209/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5109 - acc: 0.8583 - val_loss: 1.3036 - val_acc: 0.
6207

Epoch 00209: val_acc did not improve from 0.79310
Epoch 210/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5302 - acc: 0.8519 - val_loss: 1.4703 - val_acc: 0.
6897

Epoch 00210: val_acc did not improve from 0.79310
Epoch 211/300
157/157 [==============================] - 2s 11ms/step - loss: 0.6374 - acc: 0.8264 - val_loss: 1.1359 - val_acc: 0.
7069

Epoch 00211: val_acc did not improve from 0.79310
Epoch 212/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4481 - acc: 0.8710 - val_loss: 1.0460 - val_acc: 0.
7241

Epoch 00212: val_acc did not improve from 0.79310
Epoch 213/300
157/157 [==============================] - 2s 12ms/step - loss: 0.6636 - acc: 0.8137 - val_loss: 0.9825 - val_acc: 0.
7586

Epoch 00213: val_acc did not improve from 0.79310
Epoch 214/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5781 - acc: 0.8264 - val_loss: 1.5517 - val_acc: 0.
6034

Epoch 00214: val_acc did not improve from 0.79310
Epoch 215/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4213 - acc: 0.8694 - val_loss: 0.9177 - val_acc: 0.
7414

Epoch 00215: val_acc did not improve from 0.79310
Epoch 216/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3819 - acc: 0.8774 - val_loss: 1.3503 - val_acc: 0.
6897

Epoch 00216: val_acc did not improve from 0.79310
Epoch 217/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4985 - acc: 0.8599 - val_loss: 1.2170 - val_acc: 0.
```

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7069

Epoch 00217: val_acc did not improve from 0.79310
Epoch 218/300
157/157 [==============================] - 2s 13ms/step - loss: 0.5706 - acc: 0.8567 - val_loss: 0.9423 - val_acc: 0.
7069

Epoch 00218: val_acc did not improve from 0.79310
Epoch 219/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5492 - acc: 0.8503 - val_loss: 0.8977 - val_acc: 0.
7586

Epoch 00219: val_acc did not improve from 0.79310
Epoch 220/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4467 - acc: 0.8646 - val_loss: 1.2431 - val_acc: 0.
7414

Epoch 00220: val_acc did not improve from 0.79310
Epoch 221/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4478 - acc: 0.8646 - val_loss: 0.8818 - val_acc: 0.
7586

Epoch 00221: val_acc did not improve from 0.79310
Epoch 222/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4486 - acc: 0.8535 - val_loss: 1.8176 - val_acc: 0.
5517

Epoch 00222: val_acc did not improve from 0.79310
Epoch 223/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4907 - acc: 0.8662 - val_loss: 0.8768 - val_acc: 0.
8103

Epoch 00223: val_acc improved from 0.79310 to 0.81034, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Cropped/model_21.h5
Epoch 224/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4396 - acc: 0.8662 - val_loss: 1.1675 - val_acc: 0.
6897

Epoch 00224: val_acc did not improve from 0.81034
Epoch 225/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4678 - acc: 0.8646 - val_loss: 1.0200 - val_acc: 0.
7241
```

```
Epoch 00225: val_acc did not improve from 0.81034
Epoch 226/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4492 - acc: 0.8822 - val_loss: 1.2734 - val_acc: 0.
6724

Epoch 00226: val_acc did not improve from 0.81034
Epoch 227/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4294 - acc: 0.8774 - val_loss: 1.1830 - val_acc: 0.
7069

Epoch 00227: val_acc did not improve from 0.81034
Epoch 228/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4260 - acc: 0.8806 - val_loss: 1.0036 - val_acc: 0.
7414

Epoch 00228: val_acc did not improve from 0.81034
Epoch 229/300
157/157 [==============================] - 2s 12ms/step - loss: 0.3578 - acc: 0.9029 - val_loss: 0.9956 - val_acc: 0.
6724

Epoch 00229: val_acc did not improve from 0.81034
Epoch 230/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5530 - acc: 0.8392 - val_loss: 1.3439 - val_acc: 0.
6724

Epoch 00230: val_acc did not improve from 0.81034
Epoch 231/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5290 - acc: 0.8726 - val_loss: 0.9731 - val_acc: 0.
7586

Epoch 00231: val_acc did not improve from 0.81034
Epoch 232/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4809 - acc: 0.8758 - val_loss: 1.1400 - val_acc: 0.
6724

Epoch 00232: val_acc did not improve from 0.81034
Epoch 233/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4134 - acc: 0.8901 - val_loss: 1.4446 - val_acc: 0.
5862

Epoch 00233: val_acc did not improve from 0.81034
```

```
Epoch 234/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5003 - acc: 0.8615 - val_loss: 1.3831 - val_acc: 0.
6724

Epoch 00234: val_acc did not improve from 0.81034
Epoch 235/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5040 - acc: 0.8838 - val_loss: 0.9207 - val_acc: 0.
7414

Epoch 00235: val_acc did not improve from 0.81034
Epoch 236/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4711 - acc: 0.8678 - val_loss: 0.9007 - val_acc: 0.
7241

Epoch 00236: val_acc did not improve from 0.81034
Epoch 237/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4510 - acc: 0.8710 - val_loss: 1.0316 - val_acc: 0.
7414

Epoch 00237: val_acc did not improve from 0.81034
Epoch 238/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3251 - acc: 0.9061 - val_loss: 1.0941 - val_acc: 0.
7069

Epoch 00238: val_acc did not improve from 0.81034
Epoch 239/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4180 - acc: 0.8917 - val_loss: 1.1352 - val_acc: 0.
7586

Epoch 00239: val_acc did not improve from 0.81034
Epoch 240/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4833 - acc: 0.8646 - val_loss: 0.9114 - val_acc: 0.
7586

Epoch 00240: val_acc did not improve from 0.81034
Epoch 241/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5237 - acc: 0.8503 - val_loss: 1.0594 - val_acc: 0.
7759

Epoch 00241: val_acc did not improve from 0.81034
Epoch 242/300
157/157 [==============================] - 2s 13ms/step - loss: 0.4462 - acc: 0.8694 - val_loss: 0.9299 - val_acc: 0.
```

```
7586

Epoch 00242: val_acc did not improve from 0.81034
Epoch 243/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4498 - acc: 0.8694 - val_loss: 0.8997 - val_acc: 0.
7759

Epoch 00243: val_acc did not improve from 0.81034
Epoch 244/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4098 - acc: 0.8806 - val_loss: 1.2541 - val_acc: 0.
7069

Epoch 00244: val_acc did not improve from 0.81034
Epoch 245/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4811 - acc: 0.8631 - val_loss: 1.4081 - val_acc: 0.
6724

Epoch 00245: val_acc did not improve from 0.81034
Epoch 246/300
157/157 [==============================] - 2s 12ms/step - loss: 0.3778 - acc: 0.9029 - val_loss: 0.9947 - val_acc: 0.
7586

Epoch 00246: val_acc did not improve from 0.81034
Epoch 247/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4300 - acc: 0.8662 - val_loss: 1.2811 - val_acc: 0.
7069

Epoch 00247: val_acc did not improve from 0.81034
Epoch 248/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4565 - acc: 0.8806 - val_loss: 1.5542 - val_acc: 0.
6379

Epoch 00248: val_acc did not improve from 0.81034
Epoch 249/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4765 - acc: 0.8662 - val_loss: 0.8650 - val_acc: 0.
7931

Epoch 00249: val_acc did not improve from 0.81034
Epoch 250/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4874 - acc: 0.8583 - val_loss: 1.0034 - val_acc: 0.
7069
```

```
Epoch 00250: val_acc did not improve from 0.81034
Epoch 251/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5877 - acc: 0.8487 - val_loss: 0.9468 - val_acc: 0.
7241


Epoch 00251: val_acc did not improve from 0.81034
Epoch 252/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4109 - acc: 0.8774 - val_loss: 0.9530 - val_acc: 0.
7414


Epoch 00252: val_acc did not improve from 0.81034
Epoch 253/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4146 - acc: 0.8790 - val_loss: 0.9358 - val_acc: 0.
7414


Epoch 00253: val_acc did not improve from 0.81034
Epoch 254/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3984 - acc: 0.8901 - val_loss: 0.9877 - val_acc: 0.
7414


Epoch 00254: val_acc did not improve from 0.81034
Epoch 255/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4539 - acc: 0.8694 - val_loss: 1.2390 - val_acc: 0.
7069


Epoch 00255: val_acc did not improve from 0.81034
Epoch 256/300
157/157 [==============================] - 2s 12ms/step - loss: 0.3699 - acc: 0.8949 - val_loss: 0.9249 - val_acc: 0.
7069


Epoch 00256: val_acc did not improve from 0.81034
Epoch 257/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4640 - acc: 0.8710 - val_loss: 0.9565 - val_acc: 0.
7414


Epoch 00257: val_acc did not improve from 0.81034
Epoch 258/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4350 - acc: 0.8726 - val_loss: 2.4246 - val_acc: 0.
5517


Epoch 00258: val_acc did not improve from 0.81034
Epoch 259/300
```

```
157/157 [==============================] - 2s 11ms/step - loss: 0.4002 - acc: 0.8901 - val_loss: 1.3015 - val_acc: 0.
6552

Epoch 00259: val_acc did not improve from 0.81034
Epoch 260/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4936 - acc: 0.8742 - val_loss: 0.8918 - val_acc: 0.
7414

Epoch 00260: val_acc did not improve from 0.81034
Epoch 261/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4526 - acc: 0.8933 - val_loss: 1.0404 - val_acc: 0.
7414

Epoch 00261: val_acc did not improve from 0.81034
Epoch 262/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4870 - acc: 0.8647 - val_loss: 0.8435 - val_acc: 0.
7241

Epoch 00262: val_acc did not improve from 0.81034
Epoch 263/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3601 - acc: 0.8997 - val_loss: 0.7719 - val_acc: 0.
8103

Epoch 00263: val_acc did not improve from 0.81034
Epoch 264/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4744 - acc: 0.8694 - val_loss: 1.1551 - val_acc: 0.
7069

Epoch 00264: val_acc did not improve from 0.81034
Epoch 265/300
157/157 [==============================] - 2s 12ms/step - loss: 0.5532 - acc: 0.8567 - val_loss: 0.9481 - val_acc: 0.
7069

Epoch 00265: val_acc did not improve from 0.81034
Epoch 266/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4154 - acc: 0.8806 - val_loss: 0.9167 - val_acc: 0.
7414

Epoch 00266: val_acc did not improve from 0.81034
Epoch 267/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3748 - acc: 0.9029 - val_loss: 1.2305 - val_acc: 0.
6897
```

```
Epoch 00267: val_acc did not improve from 0.81034
Epoch 268/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5043 - acc: 0.8838 - val_loss: 1.0379 - val_acc: 0.
6897

Epoch 00268: val_acc did not improve from 0.81034
Epoch 269/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4571 - acc: 0.8758 - val_loss: 0.9090 - val_acc: 0.
7069

Epoch 00269: val_acc did not improve from 0.81034
Epoch 270/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4834 - acc: 0.8726 - val_loss: 0.9004 - val_acc: 0.
7069

Epoch 00270: val_acc did not improve from 0.81034
Epoch 271/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3251 - acc: 0.9124 - val_loss: 1.0655 - val_acc: 0.
7241

Epoch 00271: val_acc did not improve from 0.81034
Epoch 272/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4119 - acc: 0.8806 - val_loss: 1.2941 - val_acc: 0.
6724

Epoch 00272: val_acc did not improve from 0.81034
Epoch 273/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5075 - acc: 0.8647 - val_loss: 0.9070 - val_acc: 0.
7241

Epoch 00273: val_acc did not improve from 0.81034
Epoch 274/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4390 - acc: 0.8838 - val_loss: 1.2025 - val_acc: 0.
6897

Epoch 00274: val_acc did not improve from 0.81034
Epoch 275/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4957 - acc: 0.8822 - val_loss: 1.4855 - val_acc: 0.
6034

Epoch 00275: val_acc did not improve from 0.81034
```

```
Epoch 276/300
157/157 [==============================] - 2s 13ms/step - loss: 0.4268 - acc: 0.8853 - val_loss: 2.0103 - val_acc: 0.
5172

Epoch 00276: val_acc did not improve from 0.81034
Epoch 277/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4027 - acc: 0.8758 - val_loss: 0.8768 - val_acc: 0.
7586

Epoch 00277: val_acc did not improve from 0.81034
Epoch 278/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5519 - acc: 0.8647 - val_loss: 1.4101 - val_acc: 0.
6034

Epoch 00278: val_acc did not improve from 0.81034
Epoch 279/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3829 - acc: 0.8949 - val_loss: 1.0599 - val_acc: 0.
7241

Epoch 00279: val_acc did not improve from 0.81034
Epoch 280/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3783 - acc: 0.8838 - val_loss: 0.7734 - val_acc: 0.
7759

Epoch 00280: val_acc did not improve from 0.81034
Epoch 281/300
157/157 [==============================] - 2s 12ms/step - loss: 0.3205 - acc: 0.8965 - val_loss: 0.9419 - val_acc: 0.
7414

Epoch 00281: val_acc did not improve from 0.81034
Epoch 282/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4376 - acc: 0.8838 - val_loss: 1.6544 - val_acc: 0.
6034

Epoch 00282: val_acc did not improve from 0.81034
Epoch 283/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4162 - acc: 0.8854 - val_loss: 0.8625 - val_acc: 0.
7069

Epoch 00283: val_acc did not improve from 0.81034
Epoch 284/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4594 - acc: 0.8822 - val_loss: 0.8419 - val_acc: 0.
```

```
7414

Epoch 00284: val_acc did not improve from 0.81034
Epoch 285/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4343 - acc: 0.8885 - val_loss: 1.0393 - val_acc: 0.
7069

Epoch 00285: val_acc did not improve from 0.81034
Epoch 286/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4444 - acc: 0.8854 - val_loss: 1.2311 - val_acc: 0.
6897

Epoch 00286: val_acc did not improve from 0.81034
Epoch 287/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4491 - acc: 0.8774 - val_loss: 1.2407 - val_acc: 0.
6724

Epoch 00287: val_acc did not improve from 0.81034
Epoch 288/300
157/157 [==============================] - 2s 12ms/step - loss: 0.2549 - acc: 0.9172 - val_loss: 1.4775 - val_acc: 0.
7069

Epoch 00288: val_acc did not improve from 0.81034
Epoch 289/300
157/157 [==============================] - 2s 12ms/step - loss: 0.3915 - acc: 0.8885 - val_loss: 0.9540 - val_acc: 0.
6552

Epoch 00289: val_acc did not improve from 0.81034
Epoch 290/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3965 - acc: 0.8790 - val_loss: 0.7481 - val_acc: 0.
7586

Epoch 00290: val_acc did not improve from 0.81034
Epoch 291/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4382 - acc: 0.8822 - val_loss: 0.8553 - val_acc: 0.
7241

Epoch 00291: val_acc did not improve from 0.81034
Epoch 292/300
157/157 [==============================] - 2s 11ms/step - loss: 0.4757 - acc: 0.8822 - val_loss: 0.8630 - val_acc: 0.
6897
```

```
Epoch 00292: val_acc did not improve from 0.81034
Epoch 293/300
157/157 [==============================] - 2s 11ms/step - loss: 0.5370 - acc: 0.8631 - val_loss: 0.6763 - val_acc: 0.
7759


Epoch 00293: val_acc did not improve from 0.81034
Epoch 294/300
157/157 [==============================] - 2s 12ms/step - loss: 0.3554 - acc: 0.8965 - val_loss: 0.8853 - val_acc: 0.
7759


Epoch 00294: val_acc did not improve from 0.81034
Epoch 295/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3515 - acc: 0.8981 - val_loss: 0.9582 - val_acc: 0.
7414


Epoch 00295: val_acc did not improve from 0.81034
Epoch 296/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3622 - acc: 0.9092 - val_loss: 0.8123 - val_acc: 0.
7759


Epoch 00296: val_acc did not improve from 0.81034
Epoch 297/300
157/157 [==============================] - 2s 12ms/step - loss: 0.4174 - acc: 0.8869 - val_loss: 0.8308 - val_acc: 0.
7586


Epoch 00297: val_acc did not improve from 0.81034
Epoch 298/300
157/157 [==============================] - 2s 11ms/step - loss: 0.3734 - acc: 0.8965 - val_loss: 0.9941 - val_acc: 0.
6724


Epoch 00298: val_acc did not improve from 0.81034
Epoch 299/300
157/157 [==============================] - 3s 17ms/step - loss: 0.3469 - acc: 0.8981 - val_loss: 0.9706 - val_acc: 0.
6897


Epoch 00299: val_acc did not improve from 0.81034
Epoch 300/300
157/157 [==============================] - 3s 19ms/step - loss: 0.4675 - acc: 0.8615 - val_loss: 0.7743 - val_acc: 0.
7414


Epoch 00300: val_acc did not improve from 0.81034
```

```
In [0]: sns.set()
        plt.plot(history.history['acc'], 'r')
        plt.plot(history.history['val_acc'], 'b')
        plt.legend({'Train Accuracy': 'r', 'Test Accuracy':'b'})
        plt.show()
        plt.plot(history.history['loss'], 'r')
        plt.plot(history.history['val_loss'], 'b')
        plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
        plt.show()
```

```
In [0]: %load_ext tensorboard
```
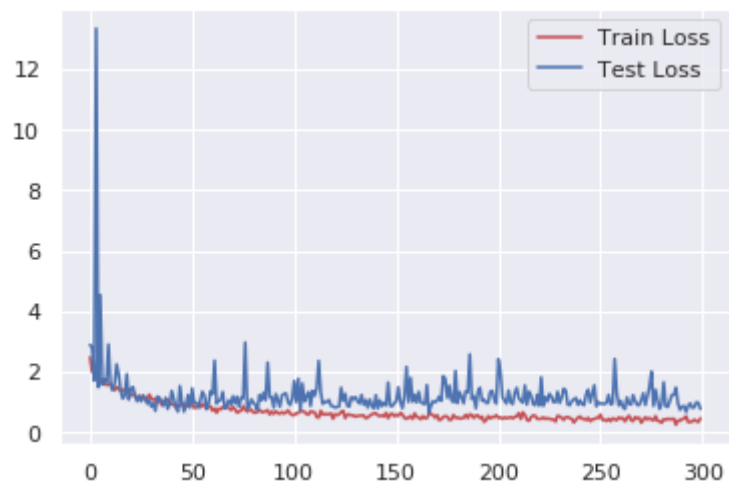
```
In [0]: %tensorboard --logdir '/content/drive/My Drive/Leaf Disease Classification/Results/Results-Cropped/graph_21'
```

Output hidden; open in https://colab.research.google.com to view.

```
In [0]: model.load_weights(path+'Results/Results-Cropped/model_21.h5')
```

```
In [28]: y_pred_tr = model.predict(X_train)

y_tr2 = y_train.argmax(1)
y_pred_tr = y_pred_tr.argmax(1)

print("Train Accuracy: ", accuracy_score(y_tr2, y_pred_tr))
```

Train Accuracy: 0.9873015873015873

```
In [27]: y_pred = model.predict(X_test)

y_te2 = y_test.argmax(1)
y_pred = y_pred.argmax(1)

print("Test Accuracy: ", accuracy_score(y_te2, y_pred))
```

Test Accuracy: 0.8103448275862069

In [0]: `plot_confusion_matrix(test_y=y_te2, predict_y=y_pred, labels=folders)`

```
Number of misclassified points  18.96551724137931
```

--- Confusion matrix ---
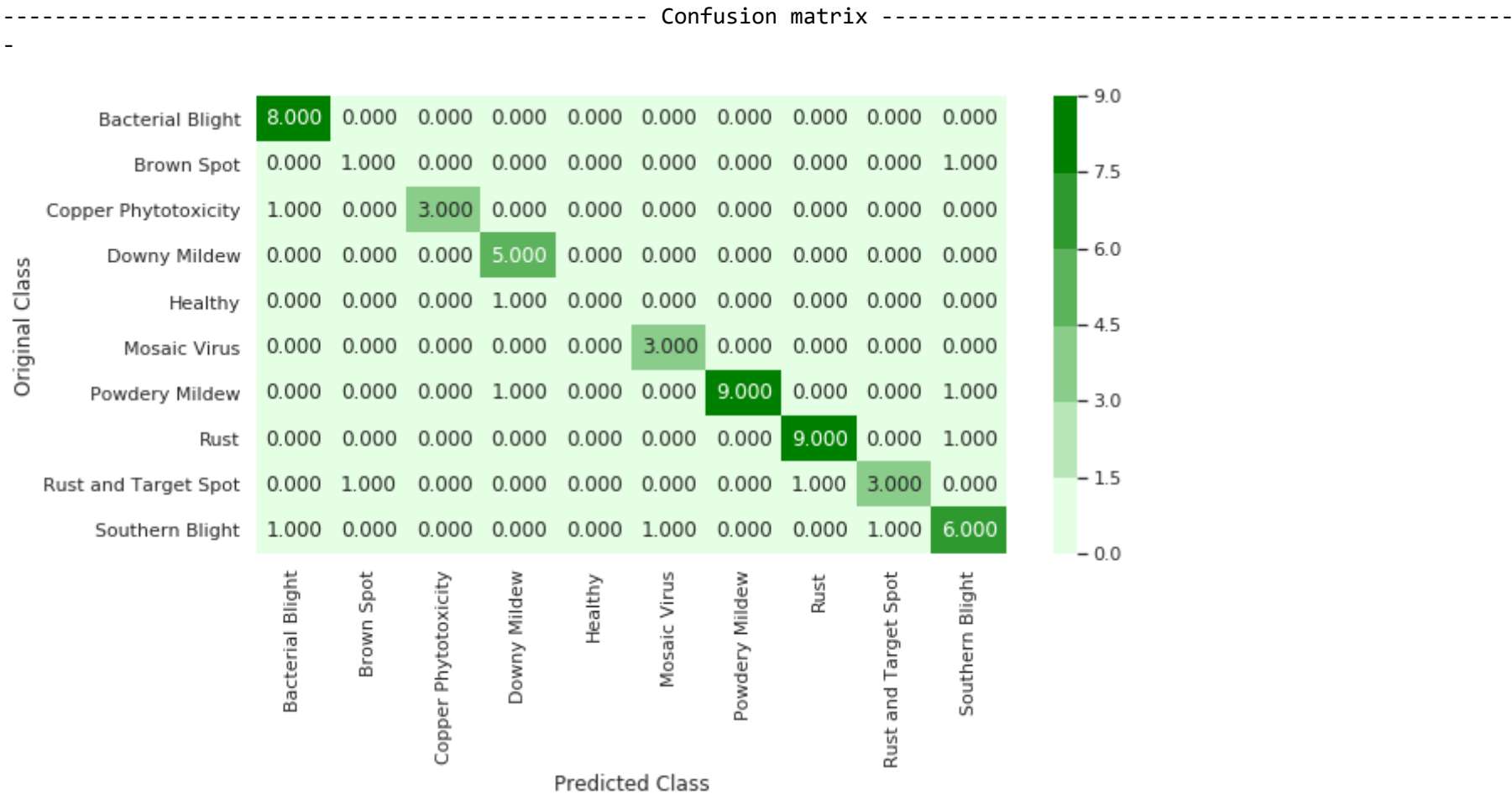
--- Precision matrix ---

Sum of columns in precision matrix [1. 1. 1. 1. nan 1. 1. 1. 1. 1.]
-- Recall matrix --
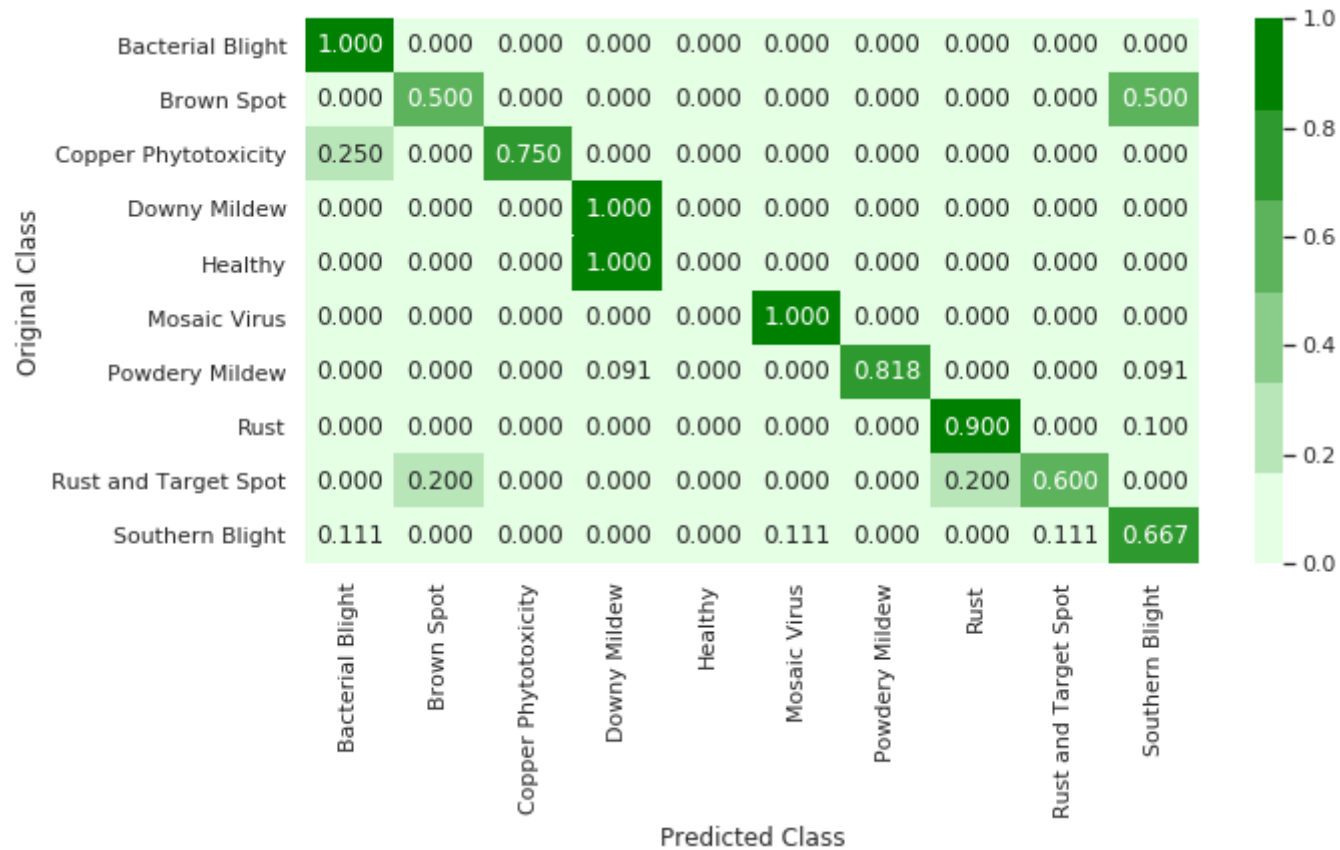
Sum of rows in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

4.3 Classification Model on Segmented Leaf Images

4.3.1 Leaf Image Segmentation using K-means Clustering Method

(a) Finding the best color space channel for color segmentation

In [0]:
```
# Here, we are trying different color spaces to find best color channel.
image = cv2.imread('/content/drive/My Drive/Leaf Disease Classification/Soyabean-Original/Bacterial Blight/IMG_0001.jp
g')

img_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
img_lab = cv2.cvtColor(image, cv2.COLOR_BGR2LAB)
img_hsv = cv2.cvtColor(image, cv2.COLOR_BGR2HSV)
```

In [0]:
```
# RGB Channel
R = img_rgb[:, :, 0]
G = img_rgb[:, :, 1]
B = img_rgb[:, :, 2]
fig, ax = plt.subplots(1,3, figsize=(15,15))
ax[0].imshow(R)
ax[1].imshow(G)
ax[2].imshow(B)
```
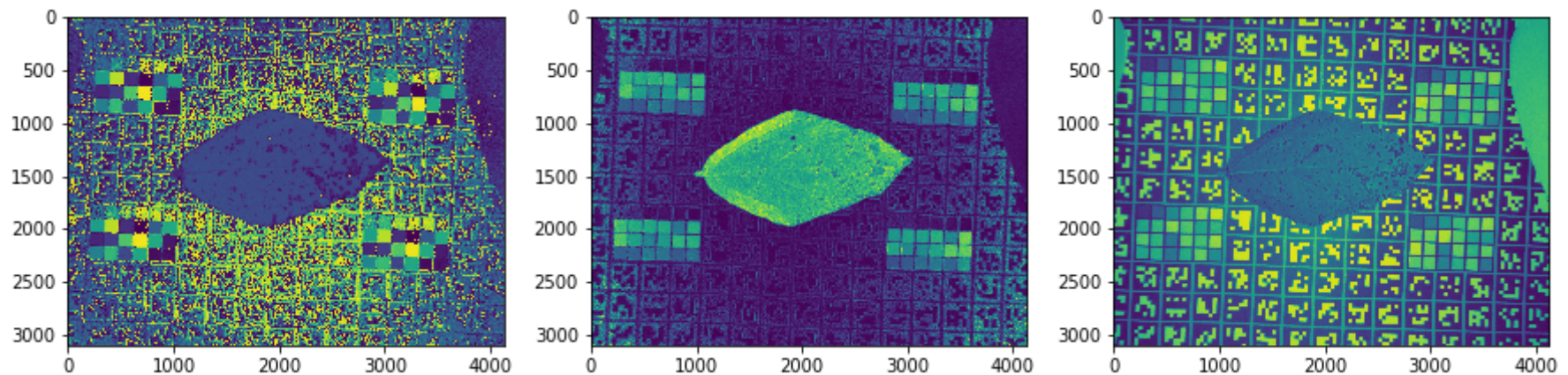
Out[0]: <matplotlib.image.AxesImage at 0x7fe82b85a7b8>
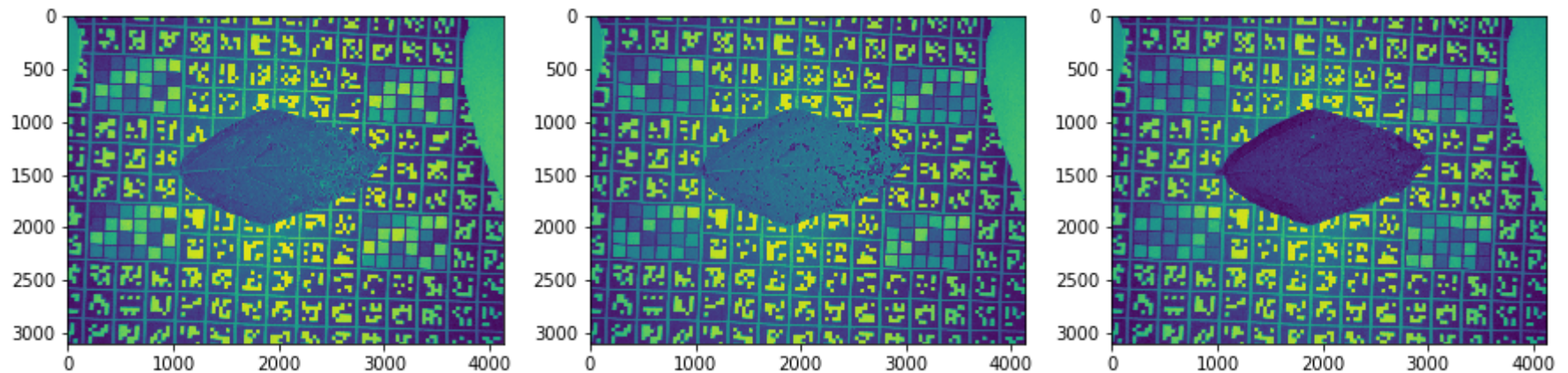
In [0]:
```python
# Lab Color Space - https://en.wikipedia.org/wiki/CIELAB_color_space
L = img_lab[:, :, 0]
a = img_lab[:, :, 1]
b = img_lab[:, :, 2]
fig, ax = plt.subplots(1,3, figsize=(15,15))
ax[0].imshow(L)
ax[1].imshow(a)
ax[2].imshow(b)
```

Out[0]: <matplotlib.image.AxesImage at 0x7fe829ad5eb8>
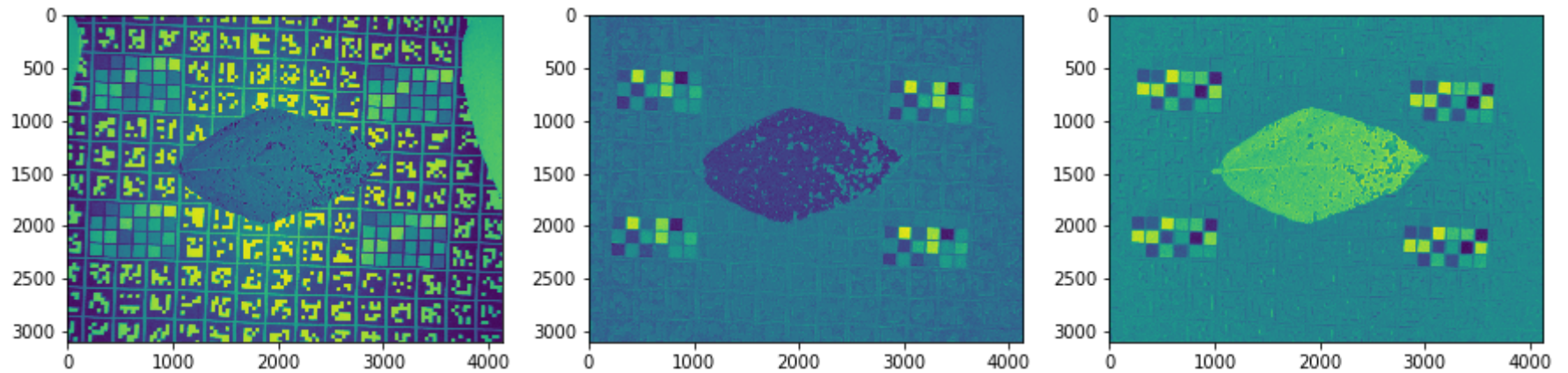
In [0]:
```python
# HSV Color Space - https://en.wikipedia.org/wiki/HSL_and_HSV
H = img_hsv[:, :, 0]
S = img_hsv[:, :, 1]
V = img_hsv[:, :, 2]
fig, ax = plt.subplots(1,3, figsize=(15,15))
ax[0].imshow(H)
ax[1].imshow(S)
ax[2].imshow(V)
```

Out[0]: <matplotlib.image.AxesImage at 0x7fe829855320>

From above, we can conclude 'b' channel from LAB color model is useful for color segmentation.

(b) K-means clustering on b channel of Lab color space

```
In [0]:  # K-means clustering in opencv - https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_ml/py_kmeans/
         py_kmeans_opencv/py_kmeans_opencv.html
         pixel_vals = b.flatten()
         pixel_vals = np.float32(pixel_vals)

         criteria = (cv2.TERM_CRITERIA_EPS + cv2.TERM_CRITERIA_MAX_ITER, 10, 1.0)
         # Since we are interested in only actual leaf pixels, we choose 2 clusters
         # one cluster for actual leaf pixels and other for unwanted background pixels.
         K = 2
         retval, labels, centers = cv2.kmeans(pixel_vals, K, None, criteria, 10, cv2.KMEANS_RANDOM_CENTERS)

         centers = np.uint8(centers)
         segmented_data = centers[labels.flatten()]

         segmented_image = segmented_data.reshape((b.shape))
         pixel_labels = labels.reshape(img_lab.shape[0], img_lab.shape[1])

         # displaying segmented image
         plt.imshow(segmented_image)
```
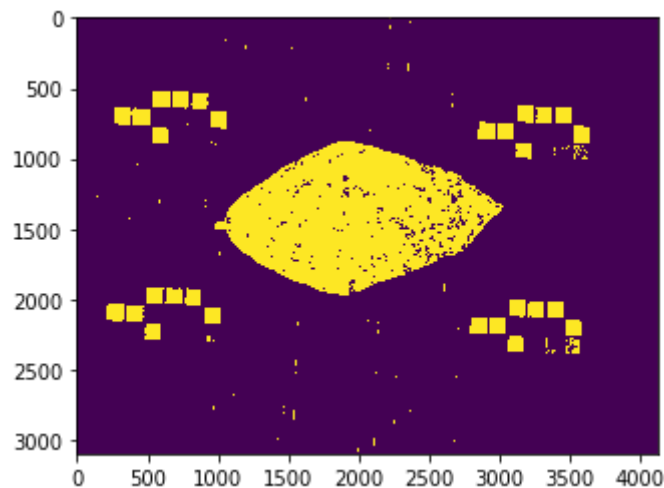
Out[0]: <matplotlib.image.AxesImage at 0x7fc86f46f438>

(c) Finding connected components in 2-clustered pixel labels

In [0]:
```python
# Now, we find connected components among clustered pixels
# Doing this, some unwanted pixels that are clustered in main cluster can be avoided.
# Ref - https://docs.opencv.org/3.4/d3/dc0/group__imgproc__shape.html#gac2718a64ade63475425558aa669a943a
pixel_labels = np.uint8(pixel_labels)
ret, components = cv2.connectedComponents(pixel_labels, connectivity=8)
plt.imshow(components, cmap='gray')
```

Out[0]: <matplotlib.image.AxesImage at 0x7fc86f3b2da0>
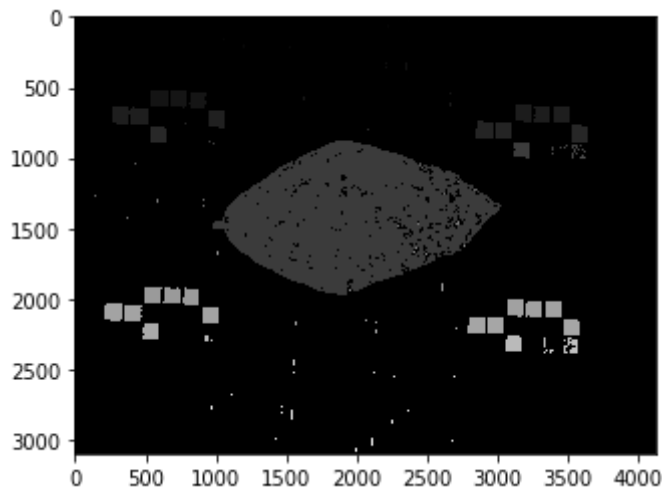


(d) Finding the main cluster to which actual leaf belongs

In [0]:
```python
# Here, we find the component in main cluster where actual leaf pixels lie
# Logic: largest component has actual leaf pixels
# So, we find largest component using max no. of rows/cols in components
indices = []
for i in range(1, ret):
    row, col = np.where(components==i)
    indices.append(max(len(row), len(col)))

cluster = np.argmax(np.array(indices))
cluster = cluster+1    #indexing starts from 0, so we increment by 1 to get actual cluster index
```

In [0]:
```python
# creating a mask and extracting pixels corresponding to cluster to which leaf belongs.
# 1 for actual leaf pixels and 0 for other pixels
mask = np.where(components==cluster, 1, 0)

B = image[:, :, 0]
G = image[:, :, 1]
R = image[:, :, 2]

# Extract only masked pixels
r = R*mask
g = G*mask
b = B*mask

final_img = np.dstack((r, g, b))
plt.imshow(final_img)
```

Out[0]: <matplotlib.image.AxesImage at 0x7fbaf24ff160>
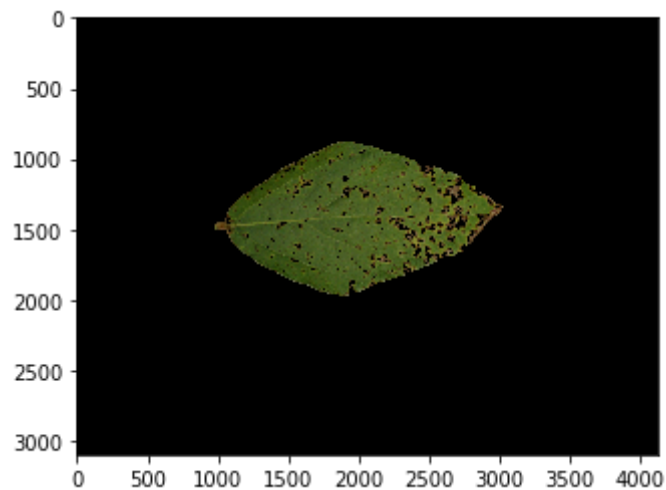
```
In [0]:  # Cropping the image by removing surrounding black pixels
         # Remove rows and columns where pixels are 0
         v_sum = np.sum(fi1, axis=0)
         h_sum = np.sum(fi1, axis=1)

         w = np.count_nonzero(v_sum)
         h = np.count_nonzero(h_sum)

         x_indices = np.where(v_sum != 0)
         y_indices = np.where(h_sum != 0)

         x = x_indices[0][0]
         y = y_indices[0][0]

         final_crop_img = final_img[y:y+h-1, x:x+w-1, :]
         final_crop_img = np.uint8(final_crop_img)
         img = cv2.resize(final_crop_img,(640,480),interpolation=cv2.INTER_AREA)
         plt.imshow(img)
```

Out[0]: <matplotlib.image.AxesImage at 0x7fbaef3ad630>
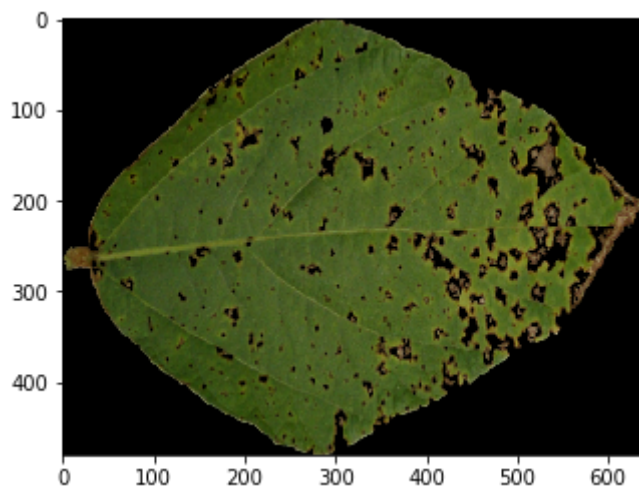
(e) Function to perform image segmentation

In [0]:
```python
src_dataset = '/content/drive/My Drive/Leaf Disease Classification/Soyabean-Original/'
dest_dataset = '/content/drive/My Drive/Leaf Disease Classification/Soyabean-Segmented/'

folders = os.listdir(src_dataset)
folders.sort()
```

In [0]:
```python
for folder in folders:
    src_folder = src_dataset+folder+os.sep

    # creating destination folders for saving preprocessed images
    os.mkdir(dest_dataset+folder+os.sep)
    dest_folder = dest_dataset+folder+os.sep

    imgs = os.listdir(src_folder)
    for img in imgs:
        image_segmentation(img, src_folder, dest_folder)
```

```
In [0]: def image_segmentation(imgname, src_folder, dest_folder):
        '''
        This function performs image segmentation on raw images based on
        K-means clustering.

        Parameters:
        imgname - image name of given image belonging to some class
        src_folder - directory/folder where image is stored
        dest_folder - directoy/folder where segmented image is stored
        '''
        image = cv2.imread(src_folder+imgname)

        # Converting RGB->Lab color space
        img_cvt = cv2.cvtColor(image, cv2.COLOR_BGR2LAB)
        b = img_cvt[:, :, 2]
        pixel_vals = b.flatten()
        pixel_vals = np.float32(pixel_vals)

        # Performing K-means clustering on 'b' channel of image
        criteria = (cv2.TERM_CRITERIA_EPS + cv2.TERM_CRITERIA_MAX_ITER, 10, 1.0)
        K = 2
        retval, labels, centers = cv2.kmeans(pixel_vals, K, None, criteria, 10, cv2.KMEANS_RANDOM_CENTERS)
        pixel_labels = labels.reshape(image.shape[0], image.shape[1])

        # Finding connected components in clusters
        ret, components = cv2.connectedComponents(pixel_labels, connectivity=8)

        # Finding row & col indices of connected components
        indices = []
        for i in range(1, ret):
            row, col = np.where(components==i)
            indices.append(len(col))

        cluster = np.argmax(np.array(indices))
        cluster = cluster+1

        mask = np.where(components==cluster, 1, 0)

        B = image[:, :, 0]
        G = image[:, :, 1]
        R = image[:, :, 2]
```

```
r = R*mask
g = G*mask
b = B*mask

final_img = np.dstack((r, g, b))

# Finding x&y indices to crop image
v_sum = np.sum(mask, axis=0)
h_sum = np.sum(mask, axis=1)

w = np.count_nonzero(v_sum)
h = np.count_nonzero(h_sum)

x_indices = np.where(v_sum != 0)
y_indices = np.where(h_sum != 0)

x = x_indices[0][0]
y = y_indices[0][0]

final_crop_img = final_img[y:y+h-1, x:x+w-1, :]
final_crop_img = np.uint8(final_crop_img)

# Resizing Image
im_resize = cv2.resize(final_crop_img,(640,480),interpolation=cv2.INTER_AREA)
im_resize = cv2.cvtColor(im_resize, cv2.COLOR_RGB2BGR)
cv2.imwrite(dest_folder+imgname, im_resize)
```

4.3.2 Preparing Data

```
In [0]: path = '/content/drive/My Drive/Leaf Disease Classification/'
        dataset = '/content/drive/My Drive/Leaf Disease Classification/Soyabean-Segmented/'
        folders = os.listdir(dataset)
        folders.sort()
```

In [0]:
```python
# Renaming image names as per our convenience
idx = 1
for folder in folders:
    imgs = os.listdir(dataset+folder+os.sep)
    imgs.sort()

    for img in imgs:
        src_name = dataset+folder+os.sep+img
        dst_name = dataset+folder+os.sep+'IMG_SEG_'+format(idx, '04d')+'.jpg'
        os.rename(src_name, dst_name)
        idx = idx+1
```

In [0]:
```python
# Storing image data in csv file
img_names = []
img_array = []
labels = []

for folder in folders:
    imgs = os.listdir(dataset+folder+os.sep)
    imgs.sort()

    for img in imgs:
        im = cv2.imread(dataset+folder+os.sep+img)
        im_rgb = cv2.cvtColor(im, cv2.COLOR_BGR2RGB)
        im_size = cv2.resize(im_rgb, (144, 144), interpolation=cv2.INTER_AREA)

        img_names.append(img)
        img_array.append(im_size)
        labels.append(folder)

df = pd.DataFrame({'Image ID': img_names, 'Class': labels})
df.to_csv(path+'Files-Segmented/soyabean_segmented.csv', index=False)

X = np.asarray(img_array)
np.save(path+'Files-Segmented/imgs_original', X)
```

In [0]:
```
data = pd.read_csv(path+'Files-Segmented/soyabean_segmented.csv')
data.head()
```

Out[0]:

	Image ID	Class
0	IMG_SEG_0001.jpg	Bacterial Blight
1	IMG_SEG_0002.jpg	Bacterial Blight
2	IMG_SEG_0003.jpg	Bacterial Blight
3	IMG_SEG_0004.jpg	Bacterial Blight
4	IMG_SEG_0005.jpg	Bacterial Blight

In [0]:
```
data['Class'].value_counts()
```

Out[0]:
```
Powdery Mildew          74
Rust                    64
Southern Blight         62
Bacterial Blight        51
Downy Mildew            33
Rust and Target Spot    32
Copper Phytotoxicity    23
Mosaic Virus            22
Brown Spot              13
Healthy                  7
Name: Class, dtype: int64
```

In [0]:
```python
# Mapping original class labels to integer values
folders = os.listdir(dataset)
folders.sort()

labels = {}
val_cnt = 0
for folder in folders:
    labels[folder] = val_cnt
    val_cnt = val_cnt+1

labels
```

Out[0]:
```
{'Bacterial Blight': 0,
 'Brown Spot': 1,
 'Copper Phytotoxicity': 2,
 'Downy Mildew': 3,
 'Healthy': 4,
 'Mosaic Virus': 5,
 'Powdery Mildew': 6,
 'Rust': 7,
 'Rust and Target Spot': 8,
 'Southern Blight': 9}
```

In [0]:
```python
X = np.load(path+'Files-Segmented/imgs_original.npy')
y = data['Class'].map(labels).values

data['Image Array'] = X.tolist()
data['Labels'] = y

data.head()
```

Out[0]:

	Image ID	Class	Image Array	Labels
0	IMG_SEG_0001.jpg	Bacterial Blight	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	0
1	IMG_SEG_0002.jpg	Bacterial Blight	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	0
2	IMG_SEG_0003.jpg	Bacterial Blight	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	0
3	IMG_SEG_0004.jpg	Bacterial Blight	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	0
4	IMG_SEG_0005.jpg	Bacterial Blight	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	0

In [0]:
```python
X = data.drop(['Image ID', 'Class', 'Labels'], axis=1)
y = data['Labels']

X_tr, X_te, y_tr, y_te = train_test_split(X, y, test_size=0.15, stratify=y, random_state=0)
```

In [0]:
```python
imbalance_train = X_tr.copy()
imbalance_train['Labels'] = y_tr
imbalance_train['Labels'].value_counts()
```

Out[0]:
```
6     63
7     54
9     53
0     43
3     28
8     27
5     19
2     19
1     11
4      6
Name: Labels, dtype: int64
```

```
In [0]:  # Reference: upsampling in python-https://elitedatascience.com/imbalanced-classes

         # Separate majority and minority classes
         majority_class = imbalance_train[imbalance_train.Labels == 6]

         # Upsampling for imbalance dataset in python
         upsampled_classes = [majority_class]
         minority_labels = [0,1,2,3,4,5,7,8,9]

         for i in minority_labels:
             minority_class = imbalance_train[imbalance_train.Labels == i]
             minority_upsampled = resample(minority_class,
                                           replace = True,
                                           n_samples = majority_class.shape[0],
                                           random_state = 0)
             upsampled_classes.append(minority_upsampled)

         train_upsampled = pd.concat(upsampled_classes)
         print(train_upsampled['Labels'].value_counts())
```

```
9    63
8    63
7    63
6    63
5    63
4    63
3    63
2    63
1    63
0    63
Name: Labels, dtype: int64
```

```
In [0]: train_upsampled.head()
```

Out[0]:

	Image Array	Labels
215	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	6
202	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	6
222	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	6
211	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	6
212	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	6

```
In [0]: train_shuffled = train_upsampled.sample(frac=1, random_state=0)
        train_shuffled.head()
```

Out[0]:

	Image Array	Labels
142	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	5
137	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	5
91	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	3
84	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	2
247	[[[0, 0, 0], [0, 0, 0], [0, 0, 0], [0, 0, 0], ...	7

```
In [0]: X_tr1 = train_shuffled['Image Array'].values
        y_tr1 = train_shuffled['Labels'].values
```

4.3.3 CNN Models

```
In [0]: y_train = keras.utils.to_categorical(y_tr1, num_classes=10)
        y_test = keras.utils.to_categorical(y_te, num_classes=10)
```

```
In [0]: train_X = X_tr1.tolist()
        X_train = np.asarray(train_X)

        X_te1 = X_te['Image Array'].values
        test_X = X_te1.tolist()
        X_test = np.asarray(test_X)
```

```
In [0]: np.save(path+'Files-Segmented/X_train_orig', X_train)
        np.save(path+'Files-Segmented/X_test_orig', X_test)

        np.save(path+'Files-Segmented/y_train_orig', y_train)
        np.save(path+'Files-Segmented/y_test_orig', y_test)
```

```
In [0]: path = '/content/drive/My Drive/Leaf Disease Classification/'

        X_train = np.load(path+'Files-Segmented/X_train_orig.npy')
        X_test = np.load(path+'Files-Segmented/X_test_orig.npy')

        y_train = np.load(path+'Files-Segmented/y_train_orig.npy')
        y_test = np.load(path+'Files-Segmented/y_test_orig.npy')
```

```
In [7]: print(X_train.shape, X_test.shape)

        (630, 144, 144, 3) (58, 144, 144, 3)
```

```
In [0]: # Scaling pixel values - Normalization
        X_train = X_train.astype('float32')
        X_test = X_test.astype('float32')

        X_train = X_train/255
        X_test = X_test/255
```

```
In [0]: # Model parameters
        input_shape = (144, 144, 3)
        num_classes = 10
```

In [0]:
```python
# Performing Data Augmentation on training data
datagen = ImageDataGenerator(horizontal_flip=True,
                             vertical_flip=True)
datagen.fit(X_train)
it_train = datagen.flow(X_train, y_train, batch_size=4)
steps = int(X_train.shape[0]/4)
```

Model 1

In [0]:
```python
# Saving model weights and other important parameters
checkpoint = ModelCheckpoint(path+"Results/Results-Segmented/model_3.h5", monitor="val_acc",
                             mode="max", save_best_only=True, verbose=1)
tensorboard = TensorBoard(log_dir=path+'Results/Results-Segmented/graph_3', histogram_freq=4, batch_size=4,
                          update_freq='epoch')

callbacks = [checkpoint, tensorboard]
```

```
In [23]:  model1 = Sequential()
          model1.add(Conv2D(32, (3, 3), activation='relu', padding='same', strides=(2, 2),
                            kernel_initializer='he_normal', input_shape=input_shape))
          model1.add(Conv2D(64, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
          model1.add(MaxPooling2D(pool_size=(2, 2)))
          model1.add(BatchNormalization())
          model1.add(Dropout(0.2))

          model1.add(Conv2D(128, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
          model1.add(Conv2D(128, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
          model1.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
          model1.add(MaxPooling2D(pool_size=(2, 2)))
          model1.add(BatchNormalization())
          model1.add(Dropout(0.3))

          model1.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
          model1.add(Conv2D(256, (3, 3), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
          model1.add(MaxPooling2D(pool_size=(2, 2)))
          model1.add(BatchNormalization())
          model1.add(Dropout(0.3))
          model1.add(Flatten())

          model1.add(Dense(512, activation='relu', kernel_initializer='he_normal'))
          model1.add(Dropout(0.5))
          model1.add(Dense(128, activation='relu', kernel_initializer='he_normal'))
          model1.add(Dropout(0.5))
          model1.add(Dense(64, activation='relu', kernel_initializer='he_normal'))

          model1.add(Dense(num_classes, activation='softmax'))

          model1.compile(loss='categorical_crossentropy', optimizer='rmsprop', metrics=['accuracy'])
          model1.summary()
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:2041: The name tf.nn.fused_batch_norm is deprecated. Please use tf.compat.v1.nn.fused_batch_norm instead.

Model: "sequential_2"

Layer (type)	Output Shape	Param #
conv2d_5 (Conv2D)	(None, 72, 72, 32)	896
conv2d_6 (Conv2D)	(None, 72, 72, 64)	18496
max_pooling2d_3 (MaxPooling2	(None, 36, 36, 64)	0
batch_normalization_1 (Batch	(None, 36, 36, 64)	256
dropout_4 (Dropout)	(None, 36, 36, 64)	0
conv2d_7 (Conv2D)	(None, 36, 36, 128)	73856
conv2d_8 (Conv2D)	(None, 36, 36, 128)	147584
conv2d_9 (Conv2D)	(None, 36, 36, 256)	295168
max_pooling2d_4 (MaxPooling2	(None, 18, 18, 256)	0
batch_normalization_2 (Batch	(None, 18, 18, 256)	1024
dropout_5 (Dropout)	(None, 18, 18, 256)	0
conv2d_10 (Conv2D)	(None, 18, 18, 256)	590080
conv2d_11 (Conv2D)	(None, 18, 18, 256)	590080
max_pooling2d_5 (MaxPooling2	(None, 9, 9, 256)	0
batch_normalization_3 (Batch	(None, 9, 9, 256)	1024
dropout_6 (Dropout)	(None, 9, 9, 256)	0
flatten_2 (Flatten)	(None, 20736)	0

dense_4 (Dense)	(None, 512)	10617344
dropout_7 (Dropout)	(None, 512)	0
dense_5 (Dense)	(None, 128)	65664
dropout_8 (Dropout)	(None, 128)	0
dense_6 (Dense)	(None, 64)	8256
dense_7 (Dense)	(None, 10)	650

```
=================================================================
Total params: 12,410,378
Trainable params: 12,409,226
Non-trainable params: 1,152
_____
```

In [26]:
```
history = model1.fit_generator(it_train, steps_per_epoch=steps,
                               epochs=300, validation_data=(X_test, y_test),
                               verbose=1, callbacks=callbacks)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (f
rom tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.
assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.
assign is deprecated. Please use tf.compat.v1.assign instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1068: The name tf.summary.histogram
is deprecated. Please use tf.compat.v1.summary.histogram instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122: The name tf.summary.merge_all
is deprecated. Please use tf.compat.v1.summary.merge_all instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125: The name tf.summary.FileWrite
r is deprecated. Please use tf.compat.v1.summary.FileWriter instead.

Epoch 1/300
157/157 [==============================] - 5s 33ms/step - loss: 13.1969 - acc: 0.1242 - val_loss: 13.1396 - val_acc:
0.1379

Epoch 00001: val_acc improved from -inf to 0.13793, saving model to /content/drive/My Drive/Leaf Disease Classificati
on/Results/Results-Segmented/model_3.h5
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265: The name tf.Summary is deprec
ated. Please use tf.compat.v1.Summary instead.

Epoch 2/300
157/157 [==============================] - 3s 16ms/step - loss: 13.5754 - acc: 0.1115 - val_loss: 13.1982 - val_acc:
0.1379

Epoch 00002: val_acc did not improve from 0.13793
Epoch 3/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7187 - acc: 0.1131 - val_loss: 14.4488 - val_acc:
0.1034

Epoch 00003: val_acc did not improve from 0.13793
Epoch 4/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3979 - acc: 0.1465 - val_loss: 12.6797 - val_acc:
0.1552
```

```
Epoch 00004: val_acc improved from 0.13793 to 0.15517, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_3.h5
Epoch 5/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6665 - acc: 0.1385 - val_loss: 11.7961 - val_acc:
0.2414

Epoch 00005: val_acc improved from 0.15517 to 0.24138, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_3.h5
Epoch 6/300
157/157 [==============================] - 3s 17ms/step - loss: 14.0390 - acc: 0.1051 - val_loss: 14.3253 - val_acc:
0.0862

Epoch 00006: val_acc did not improve from 0.24138
Epoch 7/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7622 - acc: 0.1322 - val_loss: 13.9054 - val_acc:
0.1379

Epoch 00007: val_acc did not improve from 0.24138
Epoch 8/300
157/157 [==============================] - 3s 17ms/step - loss: 14.0985 - acc: 0.1162 - val_loss: 14.9270 - val_acc:
0.0690

Epoch 00008: val_acc did not improve from 0.24138
Epoch 9/300
157/157 [==============================] - 3s 17ms/step - loss: 14.2936 - acc: 0.0987 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00009: val_acc did not improve from 0.24138
Epoch 10/300
157/157 [==============================] - 3s 17ms/step - loss: 14.3332 - acc: 0.1083 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00010: val_acc did not improve from 0.24138
Epoch 11/300
157/157 [==============================] - 3s 17ms/step - loss: 14.1189 - acc: 0.1099 - val_loss: 15.2844 - val_acc:
0.0517

Epoch 00011: val_acc did not improve from 0.24138
Epoch 12/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8398 - acc: 0.1322 - val_loss: 13.6170 - val_acc:
0.1552
```

```
        Epoch 00012: val_acc did not improve from 0.24138
        Epoch 13/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.7767 - acc: 0.1322 - val_loss: 13.8949 - val_acc:
        0.1379


        Epoch 00013: val_acc did not improve from 0.24138
        Epoch 14/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.1045 - acc: 0.1210 - val_loss: 14.0150 - val_acc:
        0.1034


        Epoch 00014: val_acc did not improve from 0.24138
        Epoch 15/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.6744 - acc: 0.1354 - val_loss: 14.4507 - val_acc:
        0.1034


        Epoch 00015: val_acc did not improve from 0.24138
        Epoch 16/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.5301 - acc: 0.1529 - val_loss: 14.4507 - val_acc:
        0.1034


        Epoch 00016: val_acc did not improve from 0.24138
        Epoch 17/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.7203 - acc: 0.1354 - val_loss: 15.5623 - val_acc:
        0.0345


        Epoch 00017: val_acc did not improve from 0.24138
        Epoch 18/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.9598 - acc: 0.1258 - val_loss: 15.2844 - val_acc:
        0.0517


        Epoch 00018: val_acc did not improve from 0.24138
        Epoch 19/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.0880 - acc: 0.1147 - val_loss: 13.9834 - val_acc:
        0.1034


        Epoch 00019: val_acc did not improve from 0.24138
        Epoch 20/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.9047 - acc: 0.1274 - val_loss: 13.4793 - val_acc:
        0.1379


        Epoch 00020: val_acc did not improve from 0.24138
```

```
Epoch 21/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7111 - acc: 0.1433 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00021: val_acc did not improve from 0.24138
Epoch 22/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7025 - acc: 0.1465 - val_loss: 14.1588 - val_acc:
0.1207

Epoch 00022: val_acc did not improve from 0.24138
Epoch 23/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8271 - acc: 0.1338 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00023: val_acc did not improve from 0.24138
Epoch 24/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8693 - acc: 0.1385 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00024: val_acc did not improve from 0.24138
Epoch 25/300
157/157 [==============================] - 3s 17ms/step - loss: 14.0880 - acc: 0.1258 - val_loss: 13.8564 - val_acc:
0.1379

Epoch 00025: val_acc did not improve from 0.24138
Epoch 26/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8071 - acc: 0.1401 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00026: val_acc did not improve from 0.24138
Epoch 27/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4387 - acc: 0.1656 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00027: val_acc did not improve from 0.24138
Epoch 28/300
157/157 [==============================] - 3s 17ms/step - loss: 13.9314 - acc: 0.1322 - val_loss: 14.1741 - val_acc:
0.1207

Epoch 00028: val_acc did not improve from 0.24138
Epoch 29/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6281 - acc: 0.1545 - val_loss: 13.8952 - val_acc:
```

0.1379

Epoch 00029: val_acc did not improve from 0.24138
Epoch 30/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3885 - acc: 0.1624 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00030: val_acc did not improve from 0.24138
Epoch 31/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3206 - acc: 0.1656 - val_loss: 13.7769 - val_acc:
0.1379

Epoch 00031: val_acc did not improve from 0.24138
Epoch 32/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7439 - acc: 0.1449 - val_loss: 14.4508 - val_acc:
0.1034

Epoch 00032: val_acc did not improve from 0.24138
Epoch 33/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5328 - acc: 0.1576 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00033: val_acc did not improve from 0.24138
Epoch 34/300
157/157 [==============================] - 3s 17ms/step - loss: 13.9384 - acc: 0.1306 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00034: val_acc did not improve from 0.24138
Epoch 35/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8451 - acc: 0.1369 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00035: val_acc did not improve from 0.24138
Epoch 36/300
157/157 [==============================] - 3s 17ms/step - loss: 13.9315 - acc: 0.1338 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00036: val_acc did not improve from 0.24138
Epoch 37/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3188 - acc: 0.1720 - val_loss: 13.6170 - val_acc:
0.1552

```
Epoch 00037: val_acc did not improve from 0.24138
Epoch 38/300
157/157 [==============================] - 3s 17ms/step - loss: 13.9710 - acc: 0.1306 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00038: val_acc did not improve from 0.24138
Epoch 39/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3396 - acc: 0.1720 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00039: val_acc did not improve from 0.24138
Epoch 40/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4242 - acc: 0.1656 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00040: val_acc did not improve from 0.24138
Epoch 41/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6087 - acc: 0.1513 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00041: val_acc did not improve from 0.24138
Epoch 42/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7657 - acc: 0.1449 - val_loss: 13.6809 - val_acc:
0.1379


Epoch 00042: val_acc did not improve from 0.24138
Epoch 43/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6837 - acc: 0.1465 - val_loss: 14.4507 - val_acc:
0.1034


Epoch 00043: val_acc did not improve from 0.24138
Epoch 44/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6095 - acc: 0.1545 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00044: val_acc did not improve from 0.24138
Epoch 45/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7154 - acc: 0.1481 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00045: val_acc did not improve from 0.24138
Epoch 46/300
```

157/157 [==============================] - 3s 17ms/step - loss: 13.1724 - acc: 0.1815 - val_loss: 13.3391 - val_acc: 0.1724

Epoch 00046: val_acc did not improve from 0.24138
Epoch 47/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7959 - acc: 0.1417 - val_loss: 13.3391 - val_acc: 0.1724

Epoch 00047: val_acc did not improve from 0.24138
Epoch 48/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3933 - acc: 0.1656 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00048: val_acc did not improve from 0.24138
Epoch 49/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5496 - acc: 0.1576 - val_loss: 15.2844 - val_acc: 0.0517

Epoch 00049: val_acc did not improve from 0.24138
Epoch 50/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7825 - acc: 0.1449 - val_loss: 14.4872 - val_acc: 0.0862

Epoch 00050: val_acc did not improve from 0.24138
Epoch 51/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5999 - acc: 0.1529 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00051: val_acc did not improve from 0.24138
Epoch 52/300
157/157 [==============================] - 3s 16ms/step - loss: 13.2697 - acc: 0.1768 - val_loss: 14.1728 - val_acc: 0.1207

Epoch 00052: val_acc did not improve from 0.24138
Epoch 53/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6344 - acc: 0.1529 - val_loss: 13.6170 - val_acc: 0.1552

Epoch 00053: val_acc did not improve from 0.24138
Epoch 54/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6681 - acc: 0.1481 - val_loss: 13.6170 - val_acc: 0.1552

```
    Epoch 00054: val_acc did not improve from 0.24138
    Epoch 55/300
    157/157 [==============================] - 3s 17ms/step - loss: 13.4231 - acc: 0.1672 - val_loss: 13.8949 - val_acc:
    0.1379


    Epoch 00055: val_acc did not improve from 0.24138
    Epoch 56/300
    157/157 [==============================] - 3s 16ms/step - loss: 13.4387 - acc: 0.1624 - val_loss: 13.8949 - val_acc:
    0.1379


    Epoch 00056: val_acc did not improve from 0.24138
    Epoch 57/300
    157/157 [==============================] - 3s 17ms/step - loss: 13.0968 - acc: 0.1863 - val_loss: 13.8949 - val_acc:
    0.1379


    Epoch 00057: val_acc did not improve from 0.24138
    Epoch 58/300
    157/157 [==============================] - 3s 17ms/step - loss: 13.9684 - acc: 0.1322 - val_loss: 13.6170 - val_acc:
    0.1552


    Epoch 00058: val_acc did not improve from 0.24138
    Epoch 59/300
    157/157 [==============================] - 3s 17ms/step - loss: 13.4934 - acc: 0.1624 - val_loss: 13.6170 - val_acc:
    0.1552


    Epoch 00059: val_acc did not improve from 0.24138
    Epoch 60/300
    157/157 [==============================] - 3s 17ms/step - loss: 13.3866 - acc: 0.1688 - val_loss: 13.8949 - val_acc:
    0.1379


    Epoch 00060: val_acc did not improve from 0.24138
    Epoch 61/300
    157/157 [==============================] - 3s 17ms/step - loss: 13.5290 - acc: 0.1592 - val_loss: 13.6170 - val_acc:
    0.1552


    Epoch 00061: val_acc did not improve from 0.24138
    Epoch 62/300
    157/157 [==============================] - 3s 17ms/step - loss: 13.4515 - acc: 0.1640 - val_loss: 13.8949 - val_acc:
    0.1379


    Epoch 00062: val_acc did not improve from 0.24138
```

```
Epoch 63/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7317 - acc: 0.1481 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00063: val_acc did not improve from 0.24138
Epoch 64/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5305 - acc: 0.1592 - val_loss: 13.7814 - val_acc:
0.1379

Epoch 00064: val_acc did not improve from 0.24138
Epoch 65/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4884 - acc: 0.1608 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00065: val_acc did not improve from 0.24138
Epoch 66/300
157/157 [==============================] - 3s 16ms/step - loss: 13.8253 - acc: 0.1385 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00066: val_acc did not improve from 0.24138
Epoch 67/300
157/157 [==============================] - 3s 16ms/step - loss: 13.6227 - acc: 0.1529 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00067: val_acc did not improve from 0.24138
Epoch 68/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7483 - acc: 0.1465 - val_loss: 13.6175 - val_acc:
0.1552

Epoch 00068: val_acc did not improve from 0.24138
Epoch 69/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4758 - acc: 0.1608 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00069: val_acc did not improve from 0.24138
Epoch 70/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5464 - acc: 0.1561 - val_loss: 13.4928 - val_acc:
0.1552

Epoch 00070: val_acc did not improve from 0.24138
Epoch 71/300
157/157 [==============================] - 3s 17ms/step - loss: 13.0983 - acc: 0.1863 - val_loss: 13.0612 - val_acc:
```

0.1897

Epoch 00071: val_acc did not improve from 0.24138
Epoch 72/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5178 - acc: 0.1576 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00072: val_acc did not improve from 0.24138
Epoch 73/300
157/157 [==============================] - 3s 17ms/step - loss: 13.0498 - acc: 0.1895 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00073: val_acc did not improve from 0.24138
Epoch 74/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1678 - acc: 0.1768 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00074: val_acc did not improve from 0.24138
Epoch 75/300
157/157 [==============================] - 3s 17ms/step - loss: 14.1319 - acc: 0.1194 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00075: val_acc did not improve from 0.24138
Epoch 76/300
157/157 [==============================] - 3s 17ms/step - loss: 14.6819 - acc: 0.0876 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00076: val_acc did not improve from 0.24138
Epoch 77/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5652 - acc: 0.1529 - val_loss: 14.7400 - val_acc:
0.0690

Epoch 00077: val_acc did not improve from 0.24138
Epoch 78/300
157/157 [==============================] - 3s 17ms/step - loss: 14.2500 - acc: 0.1115 - val_loss: 15.2844 - val_acc:
0.0517

Epoch 00078: val_acc did not improve from 0.24138
Epoch 79/300
157/157 [==============================] - 3s 16ms/step - loss: 14.4596 - acc: 0.1003 - val_loss: 15.0065 - val_acc:
0.0690

```
        Epoch 00079: val_acc did not improve from 0.24138
        Epoch 80/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.1877 - acc: 0.1178 - val_loss: 14.4507 - val_acc:
        0.1034


        Epoch 00080: val_acc did not improve from 0.24138
        Epoch 81/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.0891 - acc: 0.1242 - val_loss: 15.0065 - val_acc:
        0.0690


        Epoch 00081: val_acc did not improve from 0.24138
        Epoch 82/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.1307 - acc: 0.1226 - val_loss: 15.0065 - val_acc:
        0.0690


        Epoch 00082: val_acc did not improve from 0.24138
        Epoch 83/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.2945 - acc: 0.1115 - val_loss: 14.4508 - val_acc:
        0.1034


        Epoch 00083: val_acc did not improve from 0.24138
        Epoch 84/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.2128 - acc: 0.1131 - val_loss: 15.0065 - val_acc:
        0.0690


        Epoch 00084: val_acc did not improve from 0.24138
        Epoch 85/300
        157/157 [==============================] - 3s 17ms/step - loss: 14.0943 - acc: 0.1226 - val_loss: 15.0065 - val_acc:
        0.0690


        Epoch 00085: val_acc did not improve from 0.24138
        Epoch 86/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.9587 - acc: 0.1274 - val_loss: 15.0065 - val_acc:
        0.0690


        Epoch 00086: val_acc did not improve from 0.24138
        Epoch 87/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.9896 - acc: 0.1290 - val_loss: 14.1747 - val_acc:
        0.1207


        Epoch 00087: val_acc did not improve from 0.24138
        Epoch 88/300
```

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157/157 [==============================] - 3s 16ms/step - loss: 13.6800 - acc: 0.1513 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00088: val_acc did not improve from 0.24138
Epoch 89/300
157/157 [==============================] - 3s 16ms/step - loss: 13.5499 - acc: 0.1545 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00089: val_acc did not improve from 0.24138
Epoch 90/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6653 - acc: 0.1513 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00090: val_acc did not improve from 0.24138
Epoch 91/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2303 - acc: 0.1752 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00091: val_acc did not improve from 0.24138
Epoch 92/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7275 - acc: 0.1417 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00092: val_acc did not improve from 0.24138
Epoch 93/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4731 - acc: 0.1608 - val_loss: 14.9833 - val_acc:
0.0690

Epoch 00093: val_acc did not improve from 0.24138
Epoch 94/300
157/157 [==============================] - 3s 16ms/step - loss: 13.9719 - acc: 0.1322 - val_loss: 15.0078 - val_acc:
0.0690

Epoch 00094: val_acc did not improve from 0.24138
Epoch 95/300
157/157 [==============================] - 3s 16ms/step - loss: 14.4850 - acc: 0.0971 - val_loss: 15.0065 - val_acc:
0.0690

Epoch 00095: val_acc did not improve from 0.24138
Epoch 96/300
157/157 [==============================] - 3s 17ms/step - loss: 14.2892 - acc: 0.1131 - val_loss: 15.2844 - val_acc:
0.0517
```

```
Epoch 00096: val_acc did not improve from 0.24138
Epoch 97/300
157/157 [==============================] - 3s 16ms/step - loss: 13.6846 - acc: 0.1465 - val_loss: 14.7286 - val_acc:
0.0862


Epoch 00097: val_acc did not improve from 0.24138
Epoch 98/300
157/157 [==============================] - 3s 17ms/step - loss: 14.1366 - acc: 0.1210 - val_loss: 15.0065 - val_acc:
0.0690


Epoch 00098: val_acc did not improve from 0.24138
Epoch 99/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7501 - acc: 0.1433 - val_loss: 14.1728 - val_acc:
0.1207


Epoch 00099: val_acc did not improve from 0.24138
Epoch 100/300
157/157 [==============================] - 3s 16ms/step - loss: 13.7589 - acc: 0.1401 - val_loss: 14.3432 - val_acc:
0.1034


Epoch 00100: val_acc did not improve from 0.24138
Epoch 101/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6451 - acc: 0.1529 - val_loss: 14.3122 - val_acc:
0.1034


Epoch 00101: val_acc did not improve from 0.24138
Epoch 102/300
157/157 [==============================] - 3s 16ms/step - loss: 13.4585 - acc: 0.1624 - val_loss: 14.1728 - val_acc:
0.1207


Epoch 00102: val_acc did not improve from 0.24138
Epoch 103/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4385 - acc: 0.1640 - val_loss: 14.4507 - val_acc:
0.1034


Epoch 00103: val_acc did not improve from 0.24138
Epoch 104/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3572 - acc: 0.1704 - val_loss: 14.4507 - val_acc:
0.1034


Epoch 00104: val_acc did not improve from 0.24138
```

```
Epoch 105/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5817 - acc: 0.1545 - val_loss: 14.1727 - val_acc:
0.1034

Epoch 00105: val_acc did not improve from 0.24138
Epoch 106/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8587 - acc: 0.1385 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00106: val_acc did not improve from 0.24138
Epoch 107/300
157/157 [==============================] - 3s 16ms/step - loss: 13.5597 - acc: 0.1561 - val_loss: 14.1730 - val_acc:
0.1207

Epoch 00107: val_acc did not improve from 0.24138
Epoch 108/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5529 - acc: 0.1576 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00108: val_acc did not improve from 0.24138
Epoch 109/300
157/157 [==============================] - 3s 16ms/step - loss: 13.7727 - acc: 0.1417 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00109: val_acc did not improve from 0.24138
Epoch 110/300
157/157 [==============================] - 3s 16ms/step - loss: 13.5549 - acc: 0.1576 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00110: val_acc did not improve from 0.24138
Epoch 111/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6644 - acc: 0.1465 - val_loss: 14.2980 - val_acc:
0.1034

Epoch 00111: val_acc did not improve from 0.24138
Epoch 112/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5206 - acc: 0.1592 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00112: val_acc did not improve from 0.24138
Epoch 113/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6679 - acc: 0.1481 - val_loss: 14.4507 - val_acc:
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```
0.1034

Epoch 00113: val_acc did not improve from 0.24138
Epoch 114/300
157/157 [==============================] - 3s 16ms/step - loss: 13.7087 - acc: 0.1481 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00114: val_acc did not improve from 0.24138
Epoch 115/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8989 - acc: 0.1369 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00115: val_acc did not improve from 0.24138
Epoch 116/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7998 - acc: 0.1433 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00116: val_acc did not improve from 0.24138
Epoch 117/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8067 - acc: 0.1401 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00117: val_acc did not improve from 0.24138
Epoch 118/300
157/157 [==============================] - 3s 16ms/step - loss: 13.8190 - acc: 0.1385 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00118: val_acc did not improve from 0.24138
Epoch 119/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5177 - acc: 0.1592 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00119: val_acc did not improve from 0.24138
Epoch 120/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4952 - acc: 0.1624 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00120: val_acc did not improve from 0.24138
Epoch 121/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5437 - acc: 0.1576 - val_loss: 14.1728 - val_acc:
0.1207
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        Epoch 00121: val_acc did not improve from 0.24138
        Epoch 122/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.9076 - acc: 0.1322 - val_loss: 14.2479 - val_acc:
        0.1034


        Epoch 00122: val_acc did not improve from 0.24138
        Epoch 123/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.3412 - acc: 0.1720 - val_loss: 13.9711 - val_acc:
        0.1207


        Epoch 00123: val_acc did not improve from 0.24138
        Epoch 124/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.5453 - acc: 0.1576 - val_loss: 14.1731 - val_acc:
        0.1207


        Epoch 00124: val_acc did not improve from 0.24138
        Epoch 125/300
        157/157 [==============================] - 3s 16ms/step - loss: 13.4615 - acc: 0.1624 - val_loss: 13.8949 - val_acc:
        0.1379


        Epoch 00125: val_acc did not improve from 0.24138
        Epoch 126/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.5677 - acc: 0.1576 - val_loss: 13.6170 - val_acc:
        0.1552


        Epoch 00126: val_acc did not improve from 0.24138
        Epoch 127/300
        157/157 [==============================] - 3s 16ms/step - loss: 13.6059 - acc: 0.1545 - val_loss: 13.6170 - val_acc:
        0.1552


        Epoch 00127: val_acc did not improve from 0.24138
        Epoch 128/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.4001 - acc: 0.1672 - val_loss: 13.6170 - val_acc:
        0.1552


        Epoch 00128: val_acc did not improve from 0.24138
        Epoch 129/300
        157/157 [==============================] - 3s 17ms/step - loss: 13.5576 - acc: 0.1561 - val_loss: 13.8949 - val_acc:
        0.1379


        Epoch 00129: val_acc did not improve from 0.24138
        Epoch 130/300
```

157/157 [==============================] - 3s 17ms/step - loss: 13.4489 - acc: 0.1656 - val_loss: 13.6170 - val_acc: 0.1552

Epoch 00130: val_acc did not improve from 0.24138
Epoch 131/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3037 - acc: 0.1736 - val_loss: 13.6170 - val_acc: 0.1552

Epoch 00131: val_acc did not improve from 0.24138
Epoch 132/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5915 - acc: 0.1561 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00132: val_acc did not improve from 0.24138
Epoch 133/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2948 - acc: 0.1752 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00133: val_acc did not improve from 0.24138
Epoch 134/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3562 - acc: 0.1704 - val_loss: 13.6170 - val_acc: 0.1552

Epoch 00134: val_acc did not improve from 0.24138
Epoch 135/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1673 - acc: 0.1831 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00135: val_acc did not improve from 0.24138
Epoch 136/300
157/157 [==============================] - 3s 16ms/step - loss: 13.3206 - acc: 0.1736 - val_loss: 13.6714 - val_acc: 0.1379

Epoch 00136: val_acc did not improve from 0.24138
Epoch 137/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7859 - acc: 0.1417 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00137: val_acc did not improve from 0.24138
Epoch 138/300
157/157 [==============================] - 3s 16ms/step - loss: 13.2100 - acc: 0.1799 - val_loss: 14.4507 - val_acc: 0.1034

```
Epoch 00138: val_acc did not improve from 0.24138
Epoch 139/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6076 - acc: 0.1545 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00139: val_acc did not improve from 0.24138
Epoch 140/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3360 - acc: 0.1720 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00140: val_acc did not improve from 0.24138
Epoch 141/300
157/157 [==============================] - 3s 16ms/step - loss: 13.6409 - acc: 0.1529 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00141: val_acc did not improve from 0.24138
Epoch 142/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2180 - acc: 0.1799 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00142: val_acc did not improve from 0.24138
Epoch 143/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2960 - acc: 0.1752 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00143: val_acc did not improve from 0.24138
Epoch 144/300
157/157 [==============================] - 3s 16ms/step - loss: 13.3013 - acc: 0.1736 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00144: val_acc did not improve from 0.24138
Epoch 145/300
157/157 [==============================] - 3s 16ms/step - loss: 13.1234 - acc: 0.1847 - val_loss: 13.8224 - val_acc:
0.1379


Epoch 00145: val_acc did not improve from 0.24138
Epoch 146/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3989 - acc: 0.1640 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00146: val_acc did not improve from 0.24138
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Epoch 147/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3953 - acc: 0.1688 - val_loss: 13.7355 - val_acc:
0.1207

Epoch 00147: val_acc did not improve from 0.24138
Epoch 148/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5757 - acc: 0.1560 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00148: val_acc did not improve from 0.24138
Epoch 149/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4568 - acc: 0.1640 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00149: val_acc did not improve from 0.24138
Epoch 150/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3692 - acc: 0.1688 - val_loss: 13.4011 - val_acc:
0.1552

Epoch 00150: val_acc did not improve from 0.24138
Epoch 151/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4969 - acc: 0.1608 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00151: val_acc did not improve from 0.24138
Epoch 152/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5648 - acc: 0.1561 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00152: val_acc did not improve from 0.24138
Epoch 153/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2367 - acc: 0.1783 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00153: val_acc did not improve from 0.24138
Epoch 154/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6541 - acc: 0.1529 - val_loss: 14.5868 - val_acc:
0.0862

Epoch 00154: val_acc did not improve from 0.24138
Epoch 155/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3130 - acc: 0.1736 - val_loss: 14.1728 - val_acc:
```

0.1207

Epoch 00155: val_acc did not improve from 0.24138
Epoch 156/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4746 - acc: 0.1640 - val_loss: 14.4507 - val_acc: 0.1034

Epoch 00156: val_acc did not improve from 0.24138
Epoch 157/300
157/157 [==============================] - 3s 16ms/step - loss: 13.5515 - acc: 0.1592 - val_loss: 14.4507 - val_acc: 0.1034

Epoch 00157: val_acc did not improve from 0.24138
Epoch 158/300
157/157 [==============================] - 3s 16ms/step - loss: 13.4991 - acc: 0.1592 - val_loss: 13.6170 - val_acc: 0.1552

Epoch 00158: val_acc did not improve from 0.24138
Epoch 159/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1126 - acc: 0.1847 - val_loss: 13.7152 - val_acc: 0.1379

Epoch 00159: val_acc did not improve from 0.24138
Epoch 160/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4746 - acc: 0.1640 - val_loss: 13.8949 - val_acc: 0.1379

Epoch 00160: val_acc did not improve from 0.24138
Epoch 161/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1769 - acc: 0.1783 - val_loss: 14.1728 - val_acc: 0.1207

Epoch 00161: val_acc did not improve from 0.24138
Epoch 162/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1909 - acc: 0.1783 - val_loss: 13.8960 - val_acc: 0.1379

Epoch 00162: val_acc did not improve from 0.24138
Epoch 163/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6428 - acc: 0.1529 - val_loss: 13.6170 - val_acc: 0.1552

```
Epoch 00163: val_acc did not improve from 0.24138
Epoch 164/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3807 - acc: 0.1688 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00164: val_acc did not improve from 0.24138
Epoch 165/300
157/157 [==============================] - 3s 17ms/step - loss: 13.0242 - acc: 0.1879 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00165: val_acc did not improve from 0.24138
Epoch 166/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3464 - acc: 0.1720 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00166: val_acc did not improve from 0.24138
Epoch 167/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6693 - acc: 0.1513 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00167: val_acc did not improve from 0.24138
Epoch 168/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4462 - acc: 0.1640 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00168: val_acc did not improve from 0.24138
Epoch 169/300
157/157 [==============================] - 3s 16ms/step - loss: 13.2193 - acc: 0.1783 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00169: val_acc did not improve from 0.24138
Epoch 170/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5625 - acc: 0.1576 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00170: val_acc did not improve from 0.24138
Epoch 171/300
157/157 [==============================] - 3s 16ms/step - loss: 13.5266 - acc: 0.1592 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00171: val_acc did not improve from 0.24138
Epoch 172/300
```

```
157/157 [==============================] - 3s 17ms/step - loss: 13.3666 - acc: 0.1704 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00172: val_acc did not improve from 0.24138
Epoch 173/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3419 - acc: 0.1720 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00173: val_acc did not improve from 0.24138
Epoch 174/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2436 - acc: 0.1783 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00174: val_acc did not improve from 0.24138
Epoch 175/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4340 - acc: 0.1640 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00175: val_acc did not improve from 0.24138
Epoch 176/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3718 - acc: 0.1704 - val_loss: 13.6821 - val_acc:
0.1379


Epoch 00176: val_acc did not improve from 0.24138
Epoch 177/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4303 - acc: 0.1656 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00177: val_acc did not improve from 0.24138
Epoch 178/300
157/157 [==============================] - 3s 16ms/step - loss: 13.4745 - acc: 0.1640 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00178: val_acc did not improve from 0.24138
Epoch 179/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4548 - acc: 0.1608 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00179: val_acc did not improve from 0.24138
Epoch 180/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3564 - acc: 0.1688 - val_loss: 13.8003 - val_acc:
0.1379
```

```
Epoch 00180: val_acc did not improve from 0.24138
Epoch 181/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7141 - acc: 0.1481 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00181: val_acc did not improve from 0.24138
Epoch 182/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3528 - acc: 0.1704 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00182: val_acc did not improve from 0.24138
Epoch 183/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3372 - acc: 0.1720 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00183: val_acc did not improve from 0.24138
Epoch 184/300
157/157 [==============================] - 3s 17ms/step - loss: 13.0043 - acc: 0.1911 - val_loss: 14.0251 - val_acc:
0.1207

Epoch 00184: val_acc did not improve from 0.24138
Epoch 185/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4626 - acc: 0.1624 - val_loss: 13.3450 - val_acc:
0.1724

Epoch 00185: val_acc did not improve from 0.24138
Epoch 186/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4291 - acc: 0.1640 - val_loss: 13.9661 - val_acc:
0.1034

Epoch 00186: val_acc did not improve from 0.24138
Epoch 187/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8423 - acc: 0.2006 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00187: val_acc did not improve from 0.24138
Epoch 188/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2929 - acc: 0.1752 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00188: val_acc did not improve from 0.24138
```

```
Epoch 189/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3713 - acc: 0.1688 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00189: val_acc did not improve from 0.24138
Epoch 190/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3641 - acc: 0.1688 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00190: val_acc did not improve from 0.24138
Epoch 191/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8730 - acc: 0.1975 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00191: val_acc did not improve from 0.24138
Epoch 192/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3370 - acc: 0.1704 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00192: val_acc did not improve from 0.24138
Epoch 193/300
157/157 [==============================] - 3s 16ms/step - loss: 13.4112 - acc: 0.1656 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00193: val_acc did not improve from 0.24138
Epoch 194/300
157/157 [==============================] - 3s 16ms/step - loss: 13.2896 - acc: 0.1720 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00194: val_acc did not improve from 0.24138
Epoch 195/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4154 - acc: 0.1672 - val_loss: 13.8952 - val_acc:
0.1379

Epoch 00195: val_acc did not improve from 0.24138
Epoch 196/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2330 - acc: 0.1783 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00196: val_acc did not improve from 0.24138
Epoch 197/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3134 - acc: 0.1688 - val_loss: 13.8770 - val_acc:
```

```
0.1379

Epoch 00197: val_acc did not improve from 0.24138
Epoch 198/300
157/157 [==============================] - 3s 17ms/step - loss: 14.0403 - acc: 0.1258 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00198: val_acc did not improve from 0.24138
Epoch 199/300
157/157 [==============================] - 3s 16ms/step - loss: 13.4855 - acc: 0.1608 - val_loss: 13.8951 - val_acc:
0.1379

Epoch 00199: val_acc did not improve from 0.24138
Epoch 200/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7116 - acc: 0.1449 - val_loss: 15.5623 - val_acc:
0.0345

Epoch 00200: val_acc did not improve from 0.24138
Epoch 201/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8844 - acc: 0.1354 - val_loss: 15.8402 - val_acc:
0.0172

Epoch 00201: val_acc did not improve from 0.24138
Epoch 202/300
157/157 [==============================] - 3s 17ms/step - loss: 13.9170 - acc: 0.1322 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00202: val_acc did not improve from 0.24138
Epoch 203/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6760 - acc: 0.1481 - val_loss: 15.2844 - val_acc:
0.0517

Epoch 00203: val_acc did not improve from 0.24138
Epoch 204/300
157/157 [==============================] - 3s 16ms/step - loss: 14.5178 - acc: 0.0940 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00204: val_acc did not improve from 0.24138
Epoch 205/300
157/157 [==============================] - 3s 17ms/step - loss: 14.0069 - acc: 0.1274 - val_loss: 15.0146 - val_acc:
0.0690
```

```
Epoch 00205: val_acc did not improve from 0.24138
Epoch 206/300
157/157 [==============================] - 3s 17ms/step - loss: 14.0360 - acc: 0.1274 - val_loss: 14.7286 - val_acc:
0.0862


Epoch 00206: val_acc did not improve from 0.24138
Epoch 207/300
157/157 [==============================] - 3s 17ms/step - loss: 13.6403 - acc: 0.1529 - val_loss: 14.9748 - val_acc:
0.0690


Epoch 00207: val_acc did not improve from 0.24138
Epoch 208/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7788 - acc: 0.1401 - val_loss: 15.0065 - val_acc:
0.0690


Epoch 00208: val_acc did not improve from 0.24138
Epoch 209/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7556 - acc: 0.1433 - val_loss: 15.5623 - val_acc:
0.0345


Epoch 00209: val_acc did not improve from 0.24138
Epoch 210/300
157/157 [==============================] - 3s 17ms/step - loss: 14.0459 - acc: 0.1274 - val_loss: 15.5623 - val_acc:
0.0345


Epoch 00210: val_acc did not improve from 0.24138
Epoch 211/300
157/157 [==============================] - 3s 17ms/step - loss: 13.8603 - acc: 0.1322 - val_loss: 15.2844 - val_acc:
0.0517


Epoch 00211: val_acc did not improve from 0.24138
Epoch 212/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5274 - acc: 0.1561 - val_loss: 14.4507 - val_acc:
0.1034


Epoch 00212: val_acc did not improve from 0.24138
Epoch 213/300
157/157 [==============================] - 3s 16ms/step - loss: 12.8946 - acc: 0.1959 - val_loss: 14.4507 - val_acc:
0.1034


Epoch 00213: val_acc did not improve from 0.24138
Epoch 214/300
```

```
157/157 [==============================] - 3s 17ms/step - loss: 13.6555 - acc: 0.1497 - val_loss: 15.8402 - val_acc:
0.0172

Epoch 00214: val_acc did not improve from 0.24138
Epoch 215/300
157/157 [==============================] - 3s 17ms/step - loss: 13.9689 - acc: 0.1274 - val_loss: 15.8402 - val_acc:
0.0172

Epoch 00215: val_acc did not improve from 0.24138
Epoch 216/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4306 - acc: 0.1640 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00216: val_acc did not improve from 0.24138
Epoch 217/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9869 - acc: 0.1895 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00217: val_acc did not improve from 0.24138
Epoch 218/300
157/157 [==============================] - 3s 16ms/step - loss: 13.1674 - acc: 0.1783 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00218: val_acc did not improve from 0.24138
Epoch 219/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9646 - acc: 0.1943 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00219: val_acc did not improve from 0.24138
Epoch 220/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1942 - acc: 0.1799 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00220: val_acc did not improve from 0.24138
Epoch 221/300
157/157 [==============================] - 3s 16ms/step - loss: 13.4929 - acc: 0.1624 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00221: val_acc did not improve from 0.24138
Epoch 222/300
157/157 [==============================] - 3s 16ms/step - loss: 13.3909 - acc: 0.1672 - val_loss: 13.8949 - val_acc:
0.1379
```

```
Epoch 00222: val_acc did not improve from 0.24138
Epoch 223/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5193 - acc: 0.1576 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00223: val_acc did not improve from 0.24138
Epoch 224/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7637 - acc: 0.2022 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00224: val_acc did not improve from 0.24138
Epoch 225/300
157/157 [==============================] - 3s 17ms/step - loss: 13.0638 - acc: 0.1863 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00225: val_acc did not improve from 0.24138
Epoch 226/300
157/157 [==============================] - 3s 17ms/step - loss: 12.5434 - acc: 0.2166 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00226: val_acc did not improve from 0.24138
Epoch 227/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8652 - acc: 0.1991 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00227: val_acc did not improve from 0.24138
Epoch 228/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9763 - acc: 0.1927 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00228: val_acc did not improve from 0.24138
Epoch 229/300
157/157 [==============================] - 3s 17ms/step - loss: 13.0970 - acc: 0.1847 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00229: val_acc did not improve from 0.24138
Epoch 230/300
157/157 [==============================] - 3s 16ms/step - loss: 12.5964 - acc: 0.2182 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00230: val_acc did not improve from 0.24138
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Epoch 231/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8558 - acc: 0.1990 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00231: val_acc did not improve from 0.24138
Epoch 232/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5003 - acc: 0.1624 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00232: val_acc did not improve from 0.24138
Epoch 233/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8096 - acc: 0.2038 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00233: val_acc did not improve from 0.24138
Epoch 234/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8000 - acc: 0.2038 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00234: val_acc did not improve from 0.24138
Epoch 235/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7407 - acc: 0.2070 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00235: val_acc did not improve from 0.24138
Epoch 236/300
157/157 [==============================] - 3s 16ms/step - loss: 13.1712 - acc: 0.1799 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00236: val_acc did not improve from 0.24138
Epoch 237/300
157/157 [==============================] - 3s 17ms/step - loss: 13.9506 - acc: 0.1322 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00237: val_acc did not improve from 0.24138
Epoch 238/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9814 - acc: 0.1943 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00238: val_acc did not improve from 0.24138
Epoch 239/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9619 - acc: 0.1959 - val_loss: 13.6730 - val_acc:
```

```
0.1379

Epoch 00239: val_acc did not improve from 0.24138
Epoch 240/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9325 - acc: 0.1943 - val_loss: 15.0065 - val_acc:
0.0690

Epoch 00240: val_acc did not improve from 0.24138
Epoch 241/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8093 - acc: 0.2022 - val_loss: 15.0065 - val_acc:
0.0690

Epoch 00241: val_acc did not improve from 0.24138
Epoch 242/300
157/157 [==============================] - 3s 17ms/step - loss: 13.2785 - acc: 0.1736 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00242: val_acc did not improve from 0.24138
Epoch 243/300
157/157 [==============================] - 3s 17ms/step - loss: 12.5883 - acc: 0.2150 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00243: val_acc did not improve from 0.24138
Epoch 244/300
157/157 [==============================] - 3s 16ms/step - loss: 12.7960 - acc: 0.2054 - val_loss: 13.5578 - val_acc:
0.1552

Epoch 00244: val_acc did not improve from 0.24138
Epoch 245/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9679 - acc: 0.1943 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00245: val_acc did not improve from 0.24138
Epoch 246/300
157/157 [==============================] - 3s 17ms/step - loss: 12.6762 - acc: 0.2118 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00246: val_acc did not improve from 0.24138
Epoch 247/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8563 - acc: 0.1990 - val_loss: 13.6170 - val_acc:
0.1552
```

```
Epoch 00247: val_acc did not improve from 0.24138
Epoch 248/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8088 - acc: 0.2038 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00248: val_acc did not improve from 0.24138
Epoch 249/300
157/157 [==============================] - 3s 16ms/step - loss: 12.5896 - acc: 0.2182 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00249: val_acc did not improve from 0.24138
Epoch 250/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8634 - acc: 0.1990 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00250: val_acc did not improve from 0.24138
Epoch 251/300
157/157 [==============================] - 3s 17ms/step - loss: 12.5666 - acc: 0.2150 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00251: val_acc did not improve from 0.24138
Epoch 252/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7397 - acc: 0.2086 - val_loss: 14.1729 - val_acc:
0.1207


Epoch 00252: val_acc did not improve from 0.24138
Epoch 253/300
157/157 [==============================] - 3s 16ms/step - loss: 13.3610 - acc: 0.1688 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00253: val_acc did not improve from 0.24138
Epoch 254/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1877 - acc: 0.1799 - val_loss: 13.3391 - val_acc:
0.1724


Epoch 00254: val_acc did not improve from 0.24138
Epoch 255/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8134 - acc: 0.2038 - val_loss: 13.6341 - val_acc:
0.1379


Epoch 00255: val_acc did not improve from 0.24138
Epoch 256/300
```

```
157/157 [==============================] - 3s 17ms/step - loss: 13.6435 - acc: 0.1513 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00256: val_acc did not improve from 0.24138
Epoch 257/300
157/157 [==============================] - 3s 17ms/step - loss: 13.5624 - acc: 0.1576 - val_loss: 14.4507 - val_acc:
0.1034

Epoch 00257: val_acc did not improve from 0.24138
Epoch 258/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1345 - acc: 0.1831 - val_loss: 14.7286 - val_acc:
0.0862

Epoch 00258: val_acc did not improve from 0.24138
Epoch 259/300
157/157 [==============================] - 3s 17ms/step - loss: 13.7980 - acc: 0.1417 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00259: val_acc did not improve from 0.24138
Epoch 260/300
157/157 [==============================] - 3s 16ms/step - loss: 12.7883 - acc: 0.2054 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00260: val_acc did not improve from 0.24138
Epoch 261/300
157/157 [==============================] - 3s 17ms/step - loss: 13.4231 - acc: 0.1672 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00261: val_acc did not improve from 0.24138
Epoch 262/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1265 - acc: 0.1847 - val_loss: 14.1728 - val_acc:
0.1207

Epoch 00262: val_acc did not improve from 0.24138
Epoch 263/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9680 - acc: 0.1943 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00263: val_acc did not improve from 0.24138
Epoch 264/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9355 - acc: 0.1975 - val_loss: 14.1728 - val_acc:
0.1207
```

```
Epoch 00264: val_acc did not improve from 0.24138
Epoch 265/300
157/157 [==============================] - 3s 16ms/step - loss: 13.0083 - acc: 0.1927 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00265: val_acc did not improve from 0.24138
Epoch 266/300
157/157 [==============================] - 3s 17ms/step - loss: 13.0383 - acc: 0.1911 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00266: val_acc did not improve from 0.24138
Epoch 267/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1407 - acc: 0.1847 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00267: val_acc did not improve from 0.24138
Epoch 268/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1230 - acc: 0.1847 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00268: val_acc did not improve from 0.24138
Epoch 269/300
157/157 [==============================] - 3s 17ms/step - loss: 13.1152 - acc: 0.1863 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00269: val_acc did not improve from 0.24138
Epoch 270/300
157/157 [==============================] - 3s 17ms/step - loss: 12.6275 - acc: 0.2166 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00270: val_acc did not improve from 0.24138
Epoch 271/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7697 - acc: 0.2054 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00271: val_acc did not improve from 0.24138
Epoch 272/300
157/157 [==============================] - 3s 17ms/step - loss: 13.3231 - acc: 0.1720 - val_loss: 14.1728 - val_acc:
0.1207


Epoch 00272: val_acc did not improve from 0.24138
```

```
Epoch 273/300
157/157 [==============================] - 3s 17ms/step - loss: 12.9869 - acc: 0.1943 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00273: val_acc did not improve from 0.24138
Epoch 274/300
157/157 [==============================] - 3s 16ms/step - loss: 13.2362 - acc: 0.1752 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00274: val_acc did not improve from 0.24138
Epoch 275/300
157/157 [==============================] - 3s 17ms/step - loss: 12.4647 - acc: 0.2261 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00275: val_acc did not improve from 0.24138
Epoch 276/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7447 - acc: 0.2070 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00276: val_acc did not improve from 0.24138
Epoch 277/300
157/157 [==============================] - 3s 17ms/step - loss: 12.6070 - acc: 0.2150 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00277: val_acc did not improve from 0.24138
Epoch 278/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7814 - acc: 0.2070 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00278: val_acc did not improve from 0.24138
Epoch 279/300
157/157 [==============================] - 3s 17ms/step - loss: 12.4726 - acc: 0.2229 - val_loss: 13.3391 - val_acc:
0.1724

Epoch 00279: val_acc did not improve from 0.24138
Epoch 280/300
157/157 [==============================] - 3s 17ms/step - loss: 12.2112 - acc: 0.2420 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00280: val_acc did not improve from 0.24138
Epoch 281/300
157/157 [==============================] - 3s 17ms/step - loss: 12.7302 - acc: 0.2054 - val_loss: 14.3071 - val_acc:
```

```
0.1034

Epoch 00281: val_acc did not improve from 0.24138
Epoch 282/300
157/157 [==============================] - 3s 17ms/step - loss: 12.4157 - acc: 0.2277 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00282: val_acc did not improve from 0.24138
Epoch 283/300
157/157 [==============================] - 3s 16ms/step - loss: 13.0769 - acc: 0.1863 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00283: val_acc did not improve from 0.24138
Epoch 284/300
157/157 [==============================] - 3s 17ms/step - loss: 12.8271 - acc: 0.2022 - val_loss: 13.3392 - val_acc:
0.1724

Epoch 00284: val_acc did not improve from 0.24138
Epoch 285/300
157/157 [==============================] - 3s 17ms/step - loss: 12.3633 - acc: 0.2325 - val_loss: 13.4125 - val_acc:
0.1552

Epoch 00285: val_acc did not improve from 0.24138
Epoch 286/300
157/157 [==============================] - 3s 17ms/step - loss: 12.3386 - acc: 0.2325 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00286: val_acc did not improve from 0.24138
Epoch 287/300
157/157 [==============================] - 3s 16ms/step - loss: 13.5507 - acc: 0.1576 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00287: val_acc did not improve from 0.24138
Epoch 288/300
157/157 [==============================] - 3s 16ms/step - loss: 12.9016 - acc: 0.1974 - val_loss: 13.9974 - val_acc:
0.1207

Epoch 00288: val_acc did not improve from 0.24138
Epoch 289/300
157/157 [==============================] - 3s 16ms/step - loss: 12.3967 - acc: 0.2309 - val_loss: 13.6170 - val_acc:
0.1552
```

```
Epoch 00289: val_acc did not improve from 0.24138
Epoch 290/300
157/157 [==============================] - 3s 16ms/step - loss: 11.9995 - acc: 0.2548 - val_loss: 13.0612 - val_acc:
0.1897


Epoch 00290: val_acc did not improve from 0.24138
Epoch 291/300
157/157 [==============================] - 3s 16ms/step - loss: 11.9088 - acc: 0.2612 - val_loss: 13.8949 - val_acc:
0.1379


Epoch 00291: val_acc did not improve from 0.24138
Epoch 292/300
157/157 [==============================] - 3s 16ms/step - loss: 12.2290 - acc: 0.2404 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00292: val_acc did not improve from 0.24138
Epoch 293/300
157/157 [==============================] - 3s 17ms/step - loss: 12.2233 - acc: 0.2373 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00293: val_acc did not improve from 0.24138
Epoch 294/300
157/157 [==============================] - 3s 16ms/step - loss: 12.0209 - acc: 0.2532 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00294: val_acc did not improve from 0.24138
Epoch 295/300
157/157 [==============================] - 3s 16ms/step - loss: 12.5737 - acc: 0.2182 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00295: val_acc did not improve from 0.24138
Epoch 296/300
157/157 [==============================] - 3s 17ms/step - loss: 12.0469 - acc: 0.2516 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00296: val_acc did not improve from 0.24138
Epoch 297/300
157/157 [==============================] - 3s 16ms/step - loss: 11.8792 - acc: 0.2612 - val_loss: 13.6170 - val_acc:
0.1552


Epoch 00297: val_acc did not improve from 0.24138
Epoch 298/300
```

```
157/157 [==============================] - 3s 17ms/step - loss: 11.8439 - acc: 0.2643 - val_loss: 13.8949 - val_acc:
0.1379

Epoch 00298: val_acc did not improve from 0.24138
Epoch 299/300
157/157 [==============================] - 3s 16ms/step - loss: 12.1034 - acc: 0.2484 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00299: val_acc did not improve from 0.24138
Epoch 300/300
157/157 [==============================] - 3s 17ms/step - loss: 12.3200 - acc: 0.2357 - val_loss: 13.6170 - val_acc:
0.1552

Epoch 00300: val_acc did not improve from 0.24138
```

```
In [27]: sns.set()
         plt.plot(history.history['acc'], 'r')
         plt.plot(history.history['val_acc'], 'b')
         plt.legend({'Train Accuracy': 'r', 'Test Accuracy':'b'})
         plt.show()
         plt.plot(history.history['loss'], 'r')
         plt.plot(history.history['val_loss'], 'b')
         plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
         plt.show()
```
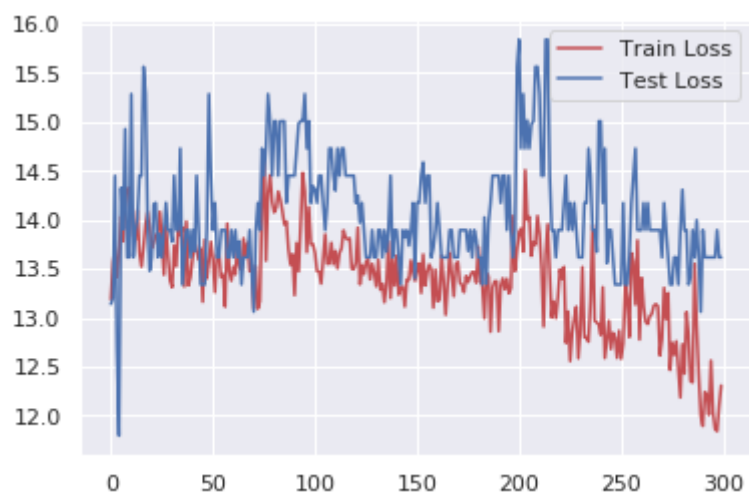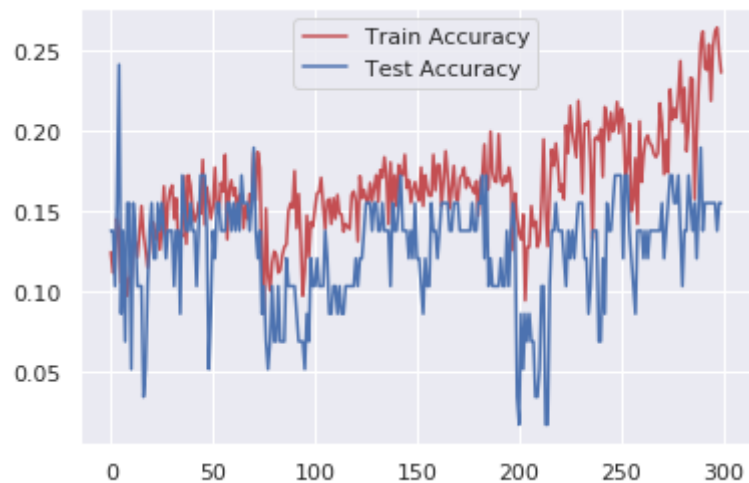
In [0]:
```
model1.load_weights(path+'Results/Results-Segmented/model_3.h5')
```

In [25]:
```
y_pred_tr = model1.predict(X_train)

y_tr2 = y_train.argmax(1)
y_pred_tr = y_pred_tr.argmax(1)

train_acc = accuracy_score(y_tr2, y_pred_tr)
print("Train Accuracy : ", train_acc)
```

Train Accuracy :   0.18253968253968253
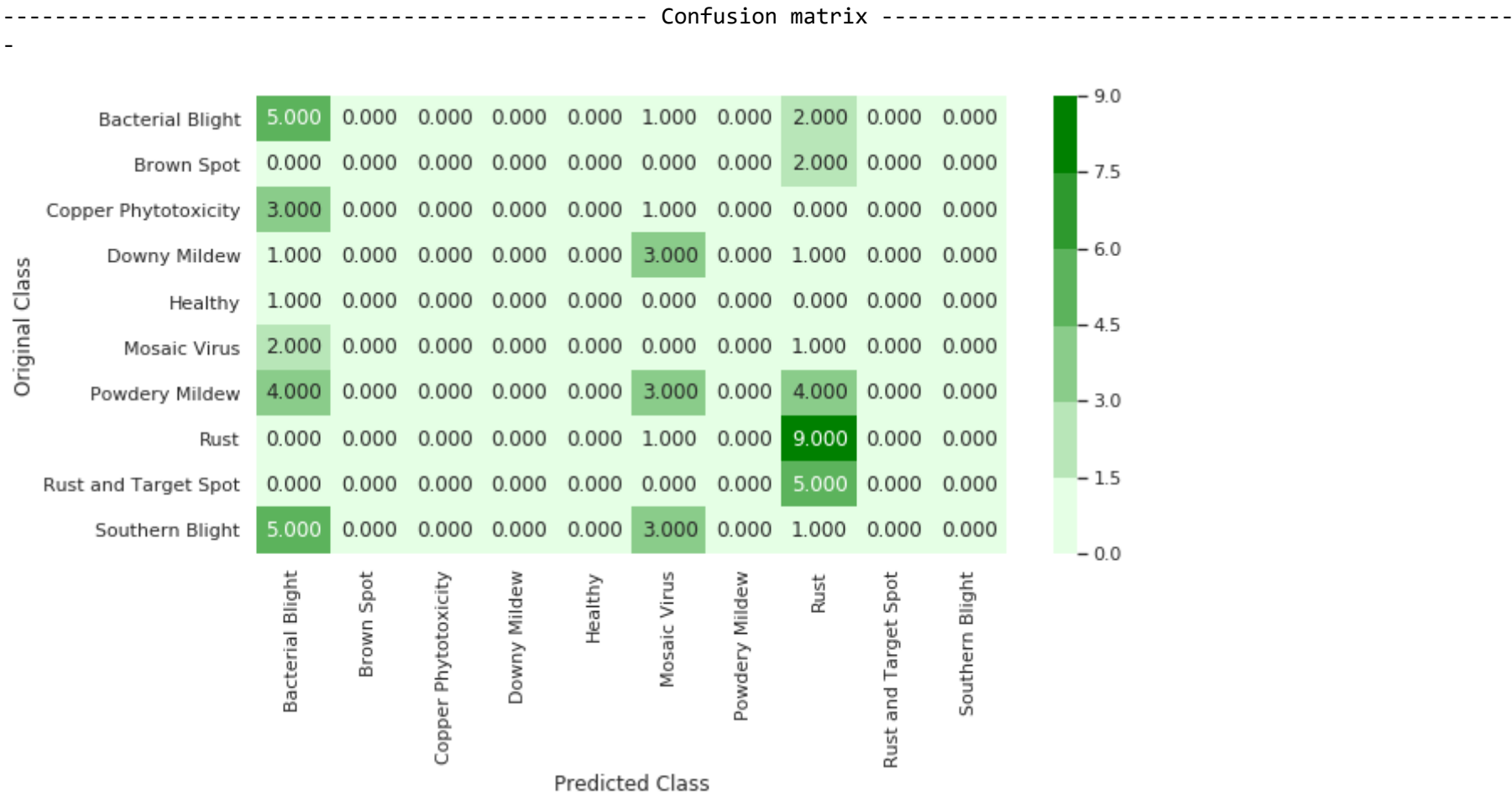
In [26]:
```
y_pred = model1.predict(X_test)

y_te2 = y_test.argmax(1)
y_pred = y_pred.argmax(1)

test_acc = accuracy_score(y_te2, y_pred)
print("Test Accuracy : ", test_acc)
```

Test Accuracy :   0.2413793103448276
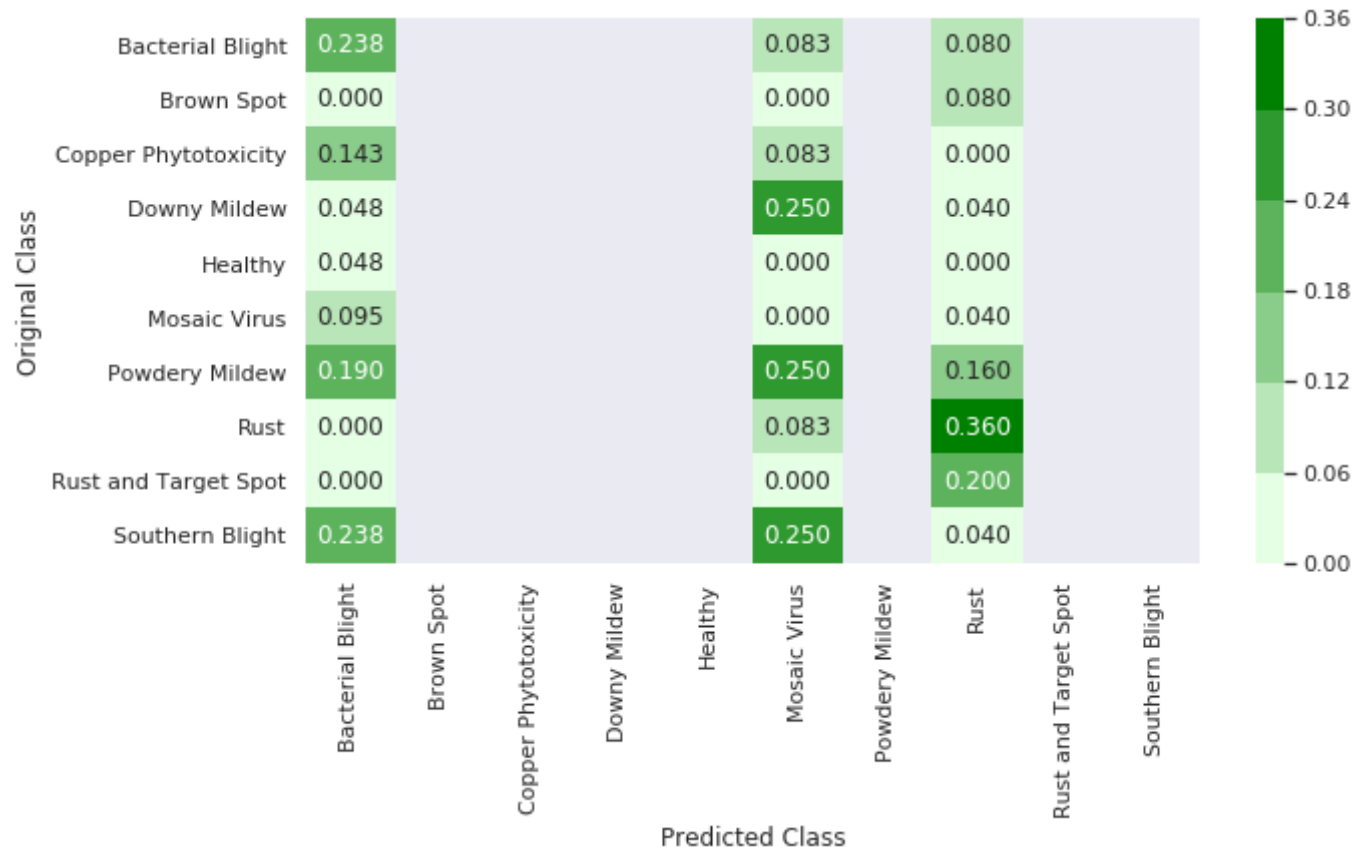
In [32]: `plot_confusion_matrix(test_y=y_te2, predict_y=y_pred, labels=folders)`

Number of misclassified points 75.86206896551724
-- Confusion matrix --
-

-- Precision matrix --
-

Sum of columns in precision matrix [1. nan nan nan nan 1. nan 1. nan nan]
-- Recall matrix --
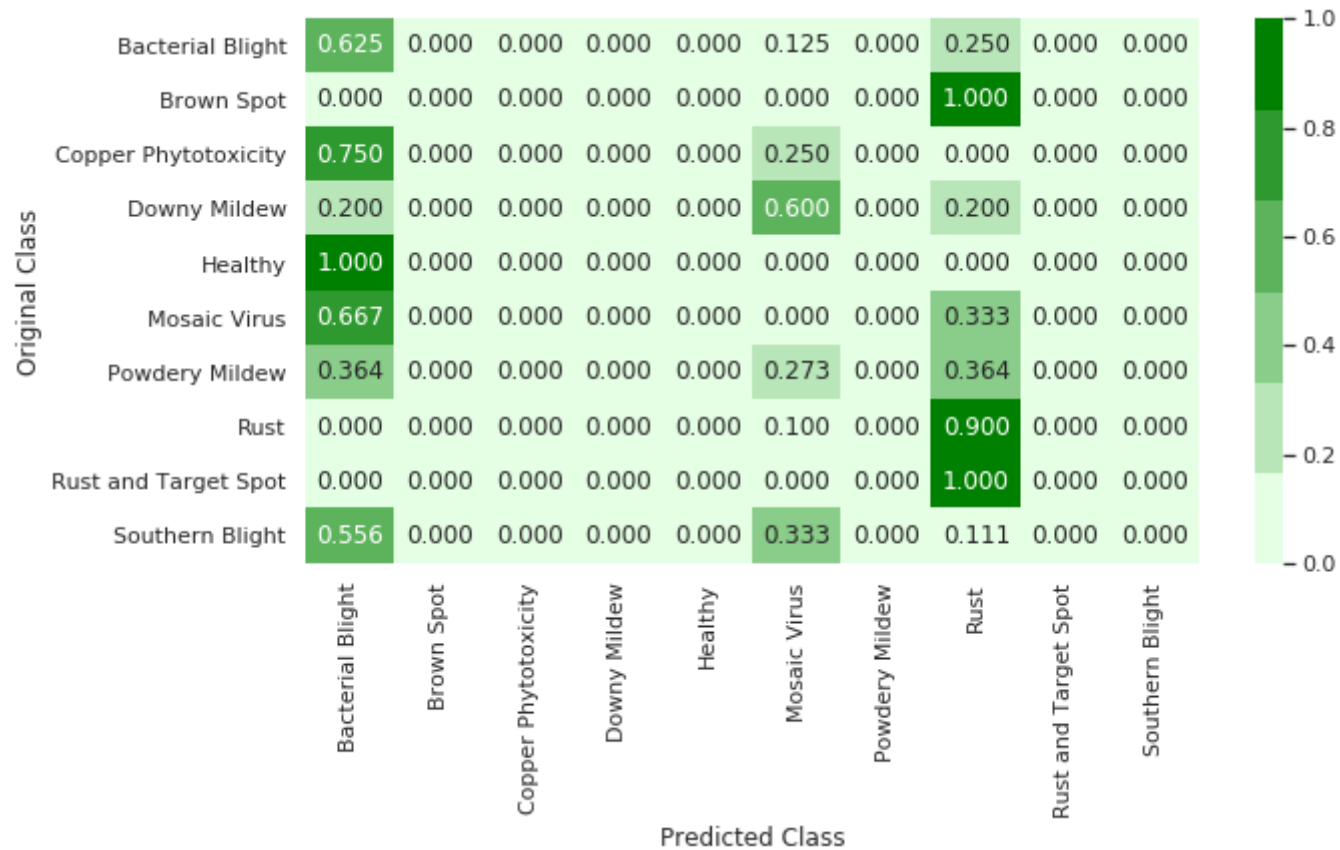
Sum of rows in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

Model 2

```
In [0]:  # Saving model weights and other important parameters
         checkpoint = ModelCheckpoint(path+"Results/Results-Segmented/model_31.h5", monitor="val_acc",
                                  mode="max", save_best_only=True, verbose=1)
         tensorboard = TensorBoard(log_dir=path+'Results/Results-Segmented/graph_31', histogram_freq=4, batch_size=4,
                                  update_freq='epoch')

         callbacks = [checkpoint, tensorboard]
```

In [12]:
```python
model = Sequential()
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', strides=(2, 2),
                    kernel_initializer='he_normal', input_shape=input_shape))
model.add(Conv2D(64, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.3))

model.add(Conv2D(128, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(Conv2D(64, (2, 2), activation='relu', padding='same', strides=(1, 1), kernel_initializer='he_normal'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.5))
model.add(Flatten())

model.add(Dense(128, activation='relu', kernel_initializer='he_normal'))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu', kernel_initializer='he_normal'))
model.add(Dense(num_classes, activation='softmax'))

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

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:66: The name tf.ge
t_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:541: The name tf.p
laceholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4479: The name tf.
truncated_normal is deprecated. Please use tf.random.truncated_normal instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4267: The name tf.
nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:148: The name tf.p
laceholder_with_default is deprecated. Please use tf.compat.v1.placeholder_with_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3733: calling drop
out (from tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4432: The name tf.
random_uniform is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793: The name tf.train.Optimizer i
s deprecated. Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3576: The name tf.
log is deprecated. Please use tf.math.log instead.

Model: "sequential_1"
_____
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 72, 72, 32)        896
_____
conv2d_2 (Conv2D)            (None, 72, 72, 64)        8256
_____
max_pooling2d_1 (MaxPooling2 (None, 36, 36, 64)        0
_____
dropout_1 (Dropout)          (None, 36, 36, 64)        0
_____
conv2d_3 (Conv2D)            (None, 36, 36, 128)       32896
```

```
_____
conv2d_4 (Conv2D)              (None, 36, 36, 64)        32832
_____
max_pooling2d_2 (MaxPooling2   (None, 18, 18, 64)        0
_____
dropout_2 (Dropout)            (None, 18, 18, 64)        0
_____
flatten_1 (Flatten)            (None, 20736)             0
_____
dense_1 (Dense)                (None, 128)               2654336
_____
dropout_3 (Dropout)            (None, 128)               0
_____
dense_2 (Dense)                (None, 64)                8256
_____
dense_3 (Dense)                (None, 10)                650
================================================================
Total params: 2,738,122
Trainable params: 2,738,122
Non-trainable params: 0
_____
```

In [13]:
```
history = model.fit_generator(it_train, steps_per_epoch=steps,
                              epochs=250, validation_data=(X_test, y_test),
                              verbose=1, callbacks=callbacks)
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (from tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.assign is deprecated. Please use tf.compat.v1.assign instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3005: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:190: The name tf.get_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:197: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:207: The name tf.global_variables is deprecated. Please use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:216: The name tf.is_variable_initialized is deprecated. Please use tf.compat.v1.is_variable_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:223: The name tf.variables_initializer is deprecated. Please use tf.compat.v1.variables_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1068: The name tf.summary.histogram is deprecated. Please use tf.compat.v1.summary.histogram instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122: The name tf.summary.merge_all is deprecated. Please use tf.compat.v1.summary.merge_all instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125: The name tf.summary.FileWriter is deprecated. Please use tf.compat.v1.summary.FileWriter instead.

Epoch 1/250
157/157 [==============================] - 3s 21ms/step - loss: 2.2716 - acc: 0.1592 - val_loss: 1.7158 - val_acc: 0.3621

```
                  Epoch 00001: val_acc improved from -inf to 0.36207, saving model to /content/drive/My Drive/Leaf Disease Classificati
                  on/Results/Results-Segmented/model_31.h5
                  WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265: The name tf.Summary is deprec
                  ated. Please use tf.compat.v1.Summary instead.


                  Epoch 2/250
                  157/157 [==============================] - 2s 10ms/step - loss: 1.8547 - acc: 0.3041 - val_loss: 1.6105 - val_acc: 0.
                  3793


                  Epoch 00002: val_acc improved from 0.36207 to 0.37931, saving model to /content/drive/My Drive/Leaf Disease Classific
                  ation/Results/Results-Segmented/model_31.h5
                  Epoch 3/250
                  157/157 [==============================] - 2s 10ms/step - loss: 1.6480 - acc: 0.4029 - val_loss: 1.4003 - val_acc: 0.
                  3966


                  Epoch 00003: val_acc improved from 0.37931 to 0.39655, saving model to /content/drive/My Drive/Leaf Disease Classific
                  ation/Results/Results-Segmented/model_31.h5
                  Epoch 4/250
                  157/157 [==============================] - 1s 9ms/step - loss: 1.4958 - acc: 0.4475 - val_loss: 1.4704 - val_acc: 0.3
                  966


                  Epoch 00004: val_acc did not improve from 0.39655
                  Epoch 5/250
                  157/157 [==============================] - 1s 9ms/step - loss: 1.3708 - acc: 0.4697 - val_loss: 1.4101 - val_acc: 0.4
                  483


                  Epoch 00005: val_acc improved from 0.39655 to 0.44828, saving model to /content/drive/My Drive/Leaf Disease Classific
                  ation/Results/Results-Segmented/model_31.h5
                  Epoch 6/250
                  157/157 [==============================] - 1s 9ms/step - loss: 1.3108 - acc: 0.5191 - val_loss: 1.3372 - val_acc: 0.5
                  000


                  Epoch 00006: val_acc improved from 0.44828 to 0.50000, saving model to /content/drive/My Drive/Leaf Disease Classific
                  ation/Results/Results-Segmented/model_31.h5
                  Epoch 7/250
                  157/157 [==============================] - 1s 9ms/step - loss: 1.1700 - acc: 0.5780 - val_loss: 1.3949 - val_acc: 0.5
                  000


                  Epoch 00007: val_acc did not improve from 0.50000
                  Epoch 8/250
                  157/157 [==============================] - 2s 10ms/step - loss: 1.0925 - acc: 0.6130 - val_loss: 1.3254 - val_acc: 0.
                  5000
```

```
Epoch 00008: val_acc did not improve from 0.50000
Epoch 9/250
157/157 [==============================] - 2s 10ms/step - loss: 1.0006 - acc: 0.6369 - val_loss: 1.0553 - val_acc: 0.
5345

Epoch 00009: val_acc improved from 0.50000 to 0.53448, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 10/250
157/157 [==============================] - 2s 10ms/step - loss: 1.0095 - acc: 0.6449 - val_loss: 1.5712 - val_acc: 0.
5345

Epoch 00010: val_acc did not improve from 0.53448
Epoch 11/250
157/157 [==============================] - 1s 10ms/step - loss: 0.8671 - acc: 0.6895 - val_loss: 1.0048 - val_acc: 0.
5517

Epoch 00011: val_acc improved from 0.53448 to 0.55172, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 12/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8074 - acc: 0.7166 - val_loss: 1.1783 - val_acc: 0.5
345

Epoch 00012: val_acc did not improve from 0.55172
Epoch 13/250
157/157 [==============================] - 2s 10ms/step - loss: 0.8439 - acc: 0.7102 - val_loss: 0.9624 - val_acc: 0.
6724

Epoch 00013: val_acc improved from 0.55172 to 0.67241, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 14/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7517 - acc: 0.7325 - val_loss: 1.0567 - val_acc: 0.5
690

Epoch 00014: val_acc did not improve from 0.67241
Epoch 15/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6658 - acc: 0.7803 - val_loss: 0.8483 - val_acc: 0.6
897

Epoch 00015: val_acc improved from 0.67241 to 0.68966, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 16/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 0.7105 - acc: 0.7627 - val_loss: 0.8485 - val_acc: 0.6
552

Epoch 00016: val_acc did not improve from 0.68966
Epoch 17/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6351 - acc: 0.7819 - val_loss: 1.3826 - val_acc: 0.5
690

Epoch 00017: val_acc did not improve from 0.68966
Epoch 18/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6080 - acc: 0.8105 - val_loss: 1.4814 - val_acc: 0.5
345

Epoch 00018: val_acc did not improve from 0.68966
Epoch 19/250
157/157 [==============================] - 1s 10ms/step - loss: 0.7437 - acc: 0.7564 - val_loss: 0.8760 - val_acc: 0.
6379

Epoch 00019: val_acc did not improve from 0.68966
Epoch 20/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6550 - acc: 0.7882 - val_loss: 0.9601 - val_acc: 0.6
724

Epoch 00020: val_acc did not improve from 0.68966
Epoch 21/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6355 - acc: 0.8137 - val_loss: 1.0236 - val_acc: 0.6
724

Epoch 00021: val_acc did not improve from 0.68966
Epoch 22/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5601 - acc: 0.8137 - val_loss: 1.5935 - val_acc: 0.6
034

Epoch 00022: val_acc did not improve from 0.68966
Epoch 23/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6563 - acc: 0.8057 - val_loss: 1.1948 - val_acc: 0.6
379

Epoch 00023: val_acc did not improve from 0.68966
Epoch 24/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4781 - acc: 0.8376 - val_loss: 1.0647 - val_acc: 0.7
069
```

```
Epoch 00024: val_acc improved from 0.68966 to 0.70690, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 25/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5320 - acc: 0.8312 - val_loss: 1.2960 - val_acc: 0.5
862

Epoch 00025: val_acc did not improve from 0.70690
Epoch 26/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5641 - acc: 0.8312 - val_loss: 0.9679 - val_acc: 0.6
552

Epoch 00026: val_acc did not improve from 0.70690
Epoch 27/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5318 - acc: 0.8280 - val_loss: 0.8587 - val_acc: 0.7
069

Epoch 00027: val_acc did not improve from 0.70690
Epoch 28/250
157/157 [==============================] - 2s 10ms/step - loss: 0.5698 - acc: 0.8312 - val_loss: 0.7465 - val_acc: 0.
7586

Epoch 00028: val_acc improved from 0.70690 to 0.75862, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 29/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4837 - acc: 0.8662 - val_loss: 1.0266 - val_acc: 0.7
414

Epoch 00029: val_acc did not improve from 0.75862
Epoch 30/250
157/157 [==============================] - 2s 10ms/step - loss: 0.6048 - acc: 0.8360 - val_loss: 0.8366 - val_acc: 0.
7241

Epoch 00030: val_acc did not improve from 0.75862
Epoch 31/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6086 - acc: 0.8646 - val_loss: 0.8684 - val_acc: 0.7
069

Epoch 00031: val_acc did not improve from 0.75862
Epoch 32/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5395 - acc: 0.8439 - val_loss: 0.9092 - val_acc: 0.6
897
```

```
Epoch 00032: val_acc did not improve from 0.75862
Epoch 33/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5393 - acc: 0.8535 - val_loss: 1.0258 - val_acc: 0.6
724

Epoch 00033: val_acc did not improve from 0.75862
Epoch 34/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4962 - acc: 0.8694 - val_loss: 0.8759 - val_acc: 0.7
586

Epoch 00034: val_acc did not improve from 0.75862
Epoch 35/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5616 - acc: 0.8567 - val_loss: 0.8753 - val_acc: 0.7
069

Epoch 00035: val_acc did not improve from 0.75862
Epoch 36/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5822 - acc: 0.8344 - val_loss: 1.0622 - val_acc: 0.7
586

Epoch 00036: val_acc did not improve from 0.75862
Epoch 37/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4735 - acc: 0.8869 - val_loss: 0.8321 - val_acc: 0.7
241

Epoch 00037: val_acc did not improve from 0.75862
Epoch 38/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6706 - acc: 0.8439 - val_loss: 1.4958 - val_acc: 0.7
414

Epoch 00038: val_acc did not improve from 0.75862
Epoch 39/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5372 - acc: 0.8853 - val_loss: 1.0533 - val_acc: 0.6
724

Epoch 00039: val_acc did not improve from 0.75862
Epoch 40/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7387 - acc: 0.8344 - val_loss: 0.8902 - val_acc: 0.7
069

Epoch 00040: val_acc did not improve from 0.75862
```

```
Epoch 41/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6437 - acc: 0.8519 - val_loss: 1.0115 - val_acc: 0.6
724

Epoch 00041: val_acc did not improve from 0.75862
Epoch 42/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5554 - acc: 0.8646 - val_loss: 1.1148 - val_acc: 0.7
069

Epoch 00042: val_acc did not improve from 0.75862
Epoch 43/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7179 - acc: 0.8296 - val_loss: 1.0317 - val_acc: 0.7
586

Epoch 00043: val_acc did not improve from 0.75862
Epoch 44/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4771 - acc: 0.8662 - val_loss: 1.0204 - val_acc: 0.7
069

Epoch 00044: val_acc did not improve from 0.75862
Epoch 45/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6159 - acc: 0.8806 - val_loss: 1.3657 - val_acc: 0.6
552

Epoch 00045: val_acc did not improve from 0.75862
Epoch 46/250
157/157 [==============================] - 1s 9ms/step - loss: 0.4971 - acc: 0.8694 - val_loss: 1.0344 - val_acc: 0.7
069

Epoch 00046: val_acc did not improve from 0.75862
Epoch 47/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6783 - acc: 0.8503 - val_loss: 0.9646 - val_acc: 0.6
552

Epoch 00047: val_acc did not improve from 0.75862
Epoch 48/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7362 - acc: 0.8424 - val_loss: 1.2843 - val_acc: 0.7
069

Epoch 00048: val_acc did not improve from 0.75862
Epoch 49/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5430 - acc: 0.8694 - val_loss: 0.7649 - val_acc: 0.6
```

897

```
Epoch 00049: val_acc did not improve from 0.75862
Epoch 50/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6177 - acc: 0.8678 - val_loss: 1.1508 - val_acc: 0.7
069

Epoch 00050: val_acc did not improve from 0.75862
Epoch 51/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5650 - acc: 0.8694 - val_loss: 0.8829 - val_acc: 0.7
759

Epoch 00051: val_acc improved from 0.75862 to 0.77586, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 52/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5906 - acc: 0.8662 - val_loss: 0.9896 - val_acc: 0.6
034

Epoch 00052: val_acc did not improve from 0.77586
Epoch 53/250
157/157 [==============================] - 2s 10ms/step - loss: 0.6132 - acc: 0.8312 - val_loss: 0.7438 - val_acc: 0.
7414

Epoch 00053: val_acc did not improve from 0.77586
Epoch 54/250
157/157 [==============================] - 2s 10ms/step - loss: 0.7314 - acc: 0.8519 - val_loss: 0.6863 - val_acc: 0.
7241

Epoch 00054: val_acc did not improve from 0.77586
Epoch 55/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6475 - acc: 0.8646 - val_loss: 0.7884 - val_acc: 0.7
586

Epoch 00055: val_acc did not improve from 0.77586
Epoch 56/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7485 - acc: 0.8646 - val_loss: 0.9856 - val_acc: 0.6
724

Epoch 00056: val_acc did not improve from 0.77586
Epoch 57/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6914 - acc: 0.8678 - val_loss: 1.0662 - val_acc: 0.7
069
```

```
Epoch 00057: val_acc did not improve from 0.77586
Epoch 58/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5555 - acc: 0.8726 - val_loss: 1.0284 - val_acc: 0.7
241

Epoch 00058: val_acc did not improve from 0.77586
Epoch 59/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6492 - acc: 0.8424 - val_loss: 1.1107 - val_acc: 0.8
276

Epoch 00059: val_acc improved from 0.77586 to 0.82759, saving model to /content/drive/My Drive/Leaf Disease Classific
ation/Results/Results-Segmented/model_31.h5
Epoch 60/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6831 - acc: 0.8599 - val_loss: 1.9424 - val_acc: 0.6
379

Epoch 00060: val_acc did not improve from 0.82759
Epoch 61/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6613 - acc: 0.8376 - val_loss: 1.8716 - val_acc: 0.7
414

Epoch 00061: val_acc did not improve from 0.82759
Epoch 62/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6468 - acc: 0.8631 - val_loss: 0.9024 - val_acc: 0.6
207

Epoch 00062: val_acc did not improve from 0.82759
Epoch 63/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8524 - acc: 0.8344 - val_loss: 1.3386 - val_acc: 0.6
897

Epoch 00063: val_acc did not improve from 0.82759
Epoch 64/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8230 - acc: 0.8137 - val_loss: 1.4837 - val_acc: 0.5
517

Epoch 00064: val_acc did not improve from 0.82759
Epoch 65/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8590 - acc: 0.8583 - val_loss: 1.6349 - val_acc: 0.6
897
```

```
Epoch 00065: val_acc did not improve from 0.82759
Epoch 66/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7243 - acc: 0.8408 - val_loss: 0.8439 - val_acc: 0.6
897

Epoch 00066: val_acc did not improve from 0.82759
Epoch 67/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6752 - acc: 0.8583 - val_loss: 1.5251 - val_acc: 0.6
552

Epoch 00067: val_acc did not improve from 0.82759
Epoch 68/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9867 - acc: 0.8328 - val_loss: 1.1485 - val_acc: 0.6
552

Epoch 00068: val_acc did not improve from 0.82759
Epoch 69/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9184 - acc: 0.8424 - val_loss: 0.8463 - val_acc: 0.6
897

Epoch 00069: val_acc did not improve from 0.82759
Epoch 70/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7745 - acc: 0.8742 - val_loss: 1.6611 - val_acc: 0.6
897

Epoch 00070: val_acc did not improve from 0.82759
Epoch 71/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9571 - acc: 0.8344 - val_loss: 0.8612 - val_acc: 0.7
414

Epoch 00071: val_acc did not improve from 0.82759
Epoch 72/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8124 - acc: 0.8503 - val_loss: 1.4794 - val_acc: 0.5
862

Epoch 00072: val_acc did not improve from 0.82759
Epoch 73/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9494 - acc: 0.8201 - val_loss: 1.6258 - val_acc: 0.7
069

Epoch 00073: val_acc did not improve from 0.82759
Epoch 74/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 0.8944 - acc: 0.8344 - val_loss: 1.0203 - val_acc: 0.7
069

Epoch 00074: val_acc did not improve from 0.82759
Epoch 75/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0841 - acc: 0.8121 - val_loss: 1.4110 - val_acc: 0.5
862

Epoch 00075: val_acc did not improve from 0.82759
Epoch 76/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8251 - acc: 0.8424 - val_loss: 0.8884 - val_acc: 0.7
069

Epoch 00076: val_acc did not improve from 0.82759
Epoch 77/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7090 - acc: 0.8535 - val_loss: 2.0719 - val_acc: 0.7
414

Epoch 00077: val_acc did not improve from 0.82759
Epoch 78/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8060 - acc: 0.8408 - val_loss: 1.2753 - val_acc: 0.6
724

Epoch 00078: val_acc did not improve from 0.82759
Epoch 79/250
157/157 [==============================] - 1s 9ms/step - loss: 0.7856 - acc: 0.8551 - val_loss: 1.7344 - val_acc: 0.6
552

Epoch 00079: val_acc did not improve from 0.82759
Epoch 80/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8563 - acc: 0.8631 - val_loss: 1.4729 - val_acc: 0.6
724

Epoch 00080: val_acc did not improve from 0.82759
Epoch 81/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0702 - acc: 0.8503 - val_loss: 1.4932 - val_acc: 0.6
034

Epoch 00081: val_acc did not improve from 0.82759
Epoch 82/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0167 - acc: 0.8551 - val_loss: 1.3145 - val_acc: 0.7
414
```

```
Epoch 00082: val_acc did not improve from 0.82759
Epoch 83/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9363 - acc: 0.8408 - val_loss: 1.6166 - val_acc: 0.6
207

Epoch 00083: val_acc did not improve from 0.82759
Epoch 84/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8160 - acc: 0.8694 - val_loss: 1.7443 - val_acc: 0.6
897

Epoch 00084: val_acc did not improve from 0.82759
Epoch 85/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9737 - acc: 0.8822 - val_loss: 1.4733 - val_acc: 0.7
241

Epoch 00085: val_acc did not improve from 0.82759
Epoch 86/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8469 - acc: 0.8678 - val_loss: 2.5922 - val_acc: 0.7
069

Epoch 00086: val_acc did not improve from 0.82759
Epoch 87/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9563 - acc: 0.8503 - val_loss: 2.2365 - val_acc: 0.6
724

Epoch 00087: val_acc did not improve from 0.82759
Epoch 88/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1764 - acc: 0.8551 - val_loss: 1.3646 - val_acc: 0.7
414

Epoch 00088: val_acc did not improve from 0.82759
Epoch 89/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9950 - acc: 0.8551 - val_loss: 1.8709 - val_acc: 0.6
552

Epoch 00089: val_acc did not improve from 0.82759
Epoch 90/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0425 - acc: 0.8583 - val_loss: 1.6579 - val_acc: 0.7
414

Epoch 00090: val_acc did not improve from 0.82759
```

```
Epoch 91/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0451 - acc: 0.8503 - val_loss: 1.9624 - val_acc: 0.6
897

Epoch 00091: val_acc did not improve from 0.82759
Epoch 92/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8965 - acc: 0.8567 - val_loss: 1.1145 - val_acc: 0.7
414

Epoch 00092: val_acc did not improve from 0.82759
Epoch 93/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8189 - acc: 0.8726 - val_loss: 2.2439 - val_acc: 0.4
655

Epoch 00093: val_acc did not improve from 0.82759
Epoch 94/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9050 - acc: 0.8264 - val_loss: 0.9569 - val_acc: 0.6
897

Epoch 00094: val_acc did not improve from 0.82759
Epoch 95/250
157/157 [==============================] - 1s 9ms/step - loss: 0.5553 - acc: 0.8885 - val_loss: 0.9561 - val_acc: 0.7
069

Epoch 00095: val_acc did not improve from 0.82759
Epoch 96/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9290 - acc: 0.8822 - val_loss: 0.6502 - val_acc: 0.7
759

Epoch 00096: val_acc did not improve from 0.82759
Epoch 97/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0550 - acc: 0.8599 - val_loss: 2.0051 - val_acc: 0.6
897

Epoch 00097: val_acc did not improve from 0.82759
Epoch 98/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1255 - acc: 0.8567 - val_loss: 2.8817 - val_acc: 0.5
517

Epoch 00098: val_acc did not improve from 0.82759
Epoch 99/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0104 - acc: 0.8567 - val_loss: 0.9921 - val_acc: 0.7
```

414

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Epoch 00099: val_acc did not improve from 0.82759
Epoch 100/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9143 - acc: 0.8535 - val_loss: 1.3699 - val_acc: 0.7
069

Epoch 00100: val_acc did not improve from 0.82759
Epoch 101/250
157/157 [==============================] - 1s 9ms/step - loss: 0.6085 - acc: 0.8854 - val_loss: 0.8467 - val_acc: 0.6
897

Epoch 00101: val_acc did not improve from 0.82759
Epoch 102/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8341 - acc: 0.8726 - val_loss: 0.8224 - val_acc: 0.6
897

Epoch 00102: val_acc did not improve from 0.82759
Epoch 103/250
157/157 [==============================] - 1s 9ms/step - loss: 0.8239 - acc: 0.8853 - val_loss: 1.9871 - val_acc: 0.7
586

Epoch 00103: val_acc did not improve from 0.82759
Epoch 104/250
157/157 [==============================] - 1s 9ms/step - loss: 1.8478 - acc: 0.8073 - val_loss: 1.4807 - val_acc: 0.6
379

Epoch 00104: val_acc did not improve from 0.82759
Epoch 105/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3099 - acc: 0.8137 - val_loss: 1.1909 - val_acc: 0.7
069

Epoch 00105: val_acc did not improve from 0.82759
Epoch 106/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1816 - acc: 0.8631 - val_loss: 1.0738 - val_acc: 0.6
897

Epoch 00106: val_acc did not improve from 0.82759
Epoch 107/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0086 - acc: 0.8185 - val_loss: 1.2868 - val_acc: 0.7
069
```

```
Epoch 00107: val_acc did not improve from 0.82759
Epoch 108/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2518 - acc: 0.8455 - val_loss: 2.9489 - val_acc: 0.6
034

Epoch 00108: val_acc did not improve from 0.82759
Epoch 109/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3898 - acc: 0.8217 - val_loss: 2.4599 - val_acc: 0.7
069

Epoch 00109: val_acc did not improve from 0.82759
Epoch 110/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2588 - acc: 0.8121 - val_loss: 4.7249 - val_acc: 0.5
345

Epoch 00110: val_acc did not improve from 0.82759
Epoch 111/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3500 - acc: 0.8025 - val_loss: 1.1900 - val_acc: 0.5
172

Epoch 00111: val_acc did not improve from 0.82759
Epoch 112/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9334 - acc: 0.8583 - val_loss: 1.8492 - val_acc: 0.6
724

Epoch 00112: val_acc did not improve from 0.82759
Epoch 113/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1514 - acc: 0.8137 - val_loss: 2.6419 - val_acc: 0.6
552

Epoch 00113: val_acc did not improve from 0.82759
Epoch 114/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0899 - acc: 0.8471 - val_loss: 0.8768 - val_acc: 0.7
069

Epoch 00114: val_acc did not improve from 0.82759
Epoch 115/250
157/157 [==============================] - 1s 10ms/step - loss: 0.9248 - acc: 0.8615 - val_loss: 2.7670 - val_acc: 0.
5172

Epoch 00115: val_acc did not improve from 0.82759
Epoch 116/250
```

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157/157 [==============================] - 1s 9ms/step - loss: 1.2510 - acc: 0.8232 - val_loss: 1.5182 - val_acc: 0.7
241

Epoch 00116: val_acc did not improve from 0.82759
Epoch 117/250
157/157 [==============================] - 2s 10ms/step - loss: 1.1227 - acc: 0.8567 - val_loss: 1.3257 - val_acc: 0.
6034

Epoch 00117: val_acc did not improve from 0.82759
Epoch 118/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0123 - acc: 0.8455 - val_loss: 2.0554 - val_acc: 0.7
241

Epoch 00118: val_acc did not improve from 0.82759
Epoch 119/250
157/157 [==============================] - 1s 9ms/step - loss: 0.9742 - acc: 0.8551 - val_loss: 1.7554 - val_acc: 0.7
931

Epoch 00119: val_acc did not improve from 0.82759
Epoch 120/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1228 - acc: 0.8615 - val_loss: 2.2856 - val_acc: 0.7
241

Epoch 00120: val_acc did not improve from 0.82759
Epoch 121/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0901 - acc: 0.8567 - val_loss: 1.9304 - val_acc: 0.6
897

Epoch 00121: val_acc did not improve from 0.82759
Epoch 122/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5555 - acc: 0.8471 - val_loss: 1.5301 - val_acc: 0.6
207

Epoch 00122: val_acc did not improve from 0.82759
Epoch 123/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2765 - acc: 0.8439 - val_loss: 1.6447 - val_acc: 0.6
552

Epoch 00123: val_acc did not improve from 0.82759
Epoch 124/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5129 - acc: 0.8487 - val_loss: 1.6453 - val_acc: 0.7
241
```

```
Epoch 00124: val_acc did not improve from 0.82759
Epoch 125/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2980 - acc: 0.8440 - val_loss: 1.7502 - val_acc: 0.6
897

Epoch 00125: val_acc did not improve from 0.82759
Epoch 126/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2964 - acc: 0.8248 - val_loss: 1.5147 - val_acc: 0.6
552

Epoch 00126: val_acc did not improve from 0.82759
Epoch 127/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5088 - acc: 0.8487 - val_loss: 1.8908 - val_acc: 0.7
586

Epoch 00127: val_acc did not improve from 0.82759
Epoch 128/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3452 - acc: 0.8185 - val_loss: 2.5651 - val_acc: 0.6
034

Epoch 00128: val_acc did not improve from 0.82759
Epoch 129/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2929 - acc: 0.8073 - val_loss: 1.8719 - val_acc: 0.7
069

Epoch 00129: val_acc did not improve from 0.82759
Epoch 130/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3377 - acc: 0.7930 - val_loss: 1.7697 - val_acc: 0.7
586

Epoch 00130: val_acc did not improve from 0.82759
Epoch 131/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0981 - acc: 0.8615 - val_loss: 1.1429 - val_acc: 0.7
069

Epoch 00131: val_acc did not improve from 0.82759
Epoch 132/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0996 - acc: 0.8280 - val_loss: 1.6352 - val_acc: 0.6
379

Epoch 00132: val_acc did not improve from 0.82759
```

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Epoch 133/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0680 - acc: 0.8232 - val_loss: 1.6725 - val_acc: 0.5
862

Epoch 00133: val_acc did not improve from 0.82759
Epoch 134/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5024 - acc: 0.7468 - val_loss: 1.8425 - val_acc: 0.7
586

Epoch 00134: val_acc did not improve from 0.82759
Epoch 135/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2970 - acc: 0.8471 - val_loss: 1.4497 - val_acc: 0.7
414

Epoch 00135: val_acc did not improve from 0.82759
Epoch 136/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2995 - acc: 0.8678 - val_loss: 1.3574 - val_acc: 0.6
552

Epoch 00136: val_acc did not improve from 0.82759
Epoch 137/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3932 - acc: 0.8551 - val_loss: 1.8561 - val_acc: 0.7
931

Epoch 00137: val_acc did not improve from 0.82759
Epoch 138/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4697 - acc: 0.8758 - val_loss: 1.1637 - val_acc: 0.7
414

Epoch 00138: val_acc did not improve from 0.82759
Epoch 139/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0807 - acc: 0.8806 - val_loss: 2.7222 - val_acc: 0.6
897

Epoch 00139: val_acc did not improve from 0.82759
Epoch 140/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4621 - acc: 0.7994 - val_loss: 1.2689 - val_acc: 0.6
379

Epoch 00140: val_acc did not improve from 0.82759
Epoch 141/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1217 - acc: 0.8408 - val_loss: 0.9830 - val_acc: 0.6
```

379

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Epoch 00141: val_acc did not improve from 0.82759
Epoch 142/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2170 - acc: 0.7898 - val_loss: 1.3672 - val_acc: 0.6
034

Epoch 00142: val_acc did not improve from 0.82759
Epoch 143/250
157/157 [==============================] - 1s 9ms/step - loss: 1.8237 - acc: 0.5382 - val_loss: 1.4169 - val_acc: 0.5
690

Epoch 00143: val_acc did not improve from 0.82759
Epoch 144/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5888 - acc: 0.8105 - val_loss: 4.1324 - val_acc: 0.5
690

Epoch 00144: val_acc did not improve from 0.82759
Epoch 145/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4621 - acc: 0.8153 - val_loss: 2.2975 - val_acc: 0.6
207

Epoch 00145: val_acc did not improve from 0.82759
Epoch 146/250
157/157 [==============================] - 1s 9ms/step - loss: 1.7713 - acc: 0.8280 - val_loss: 2.9062 - val_acc: 0.6
379

Epoch 00146: val_acc did not improve from 0.82759
Epoch 147/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4033 - acc: 0.8599 - val_loss: 2.7652 - val_acc: 0.7
241

Epoch 00147: val_acc did not improve from 0.82759
Epoch 148/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5549 - acc: 0.8487 - val_loss: 4.3973 - val_acc: 0.5
690

Epoch 00148: val_acc did not improve from 0.82759
Epoch 149/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3404 - acc: 0.8726 - val_loss: 2.1337 - val_acc: 0.7
241
```

```
Epoch 00149: val_acc did not improve from 0.82759
Epoch 150/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5242 - acc: 0.8264 - val_loss: 1.1115 - val_acc: 0.6
379


Epoch 00150: val_acc did not improve from 0.82759
Epoch 151/250
157/157 [==============================] - 1s 9ms/step - loss: 1.6495 - acc: 0.8089 - val_loss: 4.5408 - val_acc: 0.6
207


Epoch 00151: val_acc did not improve from 0.82759
Epoch 152/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4653 - acc: 0.8408 - val_loss: 3.4766 - val_acc: 0.6
379


Epoch 00152: val_acc did not improve from 0.82759
Epoch 153/250
157/157 [==============================] - 1s 9ms/step - loss: 2.1061 - acc: 0.8169 - val_loss: 2.4256 - val_acc: 0.7
241


Epoch 00153: val_acc did not improve from 0.82759
Epoch 154/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3639 - acc: 0.8599 - val_loss: 2.2461 - val_acc: 0.6
207


Epoch 00154: val_acc did not improve from 0.82759
Epoch 155/250
157/157 [==============================] - 1s 9ms/step - loss: 1.6744 - acc: 0.8296 - val_loss: 1.4953 - val_acc: 0.6
379


Epoch 00155: val_acc did not improve from 0.82759
Epoch 156/250
157/157 [==============================] - 1s 9ms/step - loss: 1.6383 - acc: 0.8280 - val_loss: 2.5335 - val_acc: 0.6
552


Epoch 00156: val_acc did not improve from 0.82759
Epoch 157/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4872 - acc: 0.8599 - val_loss: 2.9033 - val_acc: 0.7
241


Epoch 00157: val_acc did not improve from 0.82759
Epoch 158/250
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157/157 [==============================] - 1s 9ms/step - loss: 1.4293 - acc: 0.8185 - val_loss: 1.7588 - val_acc: 0.7
414

Epoch 00158: val_acc did not improve from 0.82759
Epoch 159/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3401 - acc: 0.8694 - val_loss: 2.8361 - val_acc: 0.7
759

Epoch 00159: val_acc did not improve from 0.82759
Epoch 160/250
157/157 [==============================] - 1s 9ms/step - loss: 1.9824 - acc: 0.8344 - val_loss: 5.8946 - val_acc: 0.5
690

Epoch 00160: val_acc did not improve from 0.82759
Epoch 161/250
157/157 [==============================] - 1s 9ms/step - loss: 2.0367 - acc: 0.8328 - val_loss: 1.5801 - val_acc: 0.6
724

Epoch 00161: val_acc did not improve from 0.82759
Epoch 162/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4985 - acc: 0.8678 - val_loss: 3.8993 - val_acc: 0.4
655

Epoch 00162: val_acc did not improve from 0.82759
Epoch 163/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5194 - acc: 0.8599 - val_loss: 5.7926 - val_acc: 0.5
690

Epoch 00163: val_acc did not improve from 0.82759
Epoch 164/250
157/157 [==============================] - 1s 9ms/step - loss: 1.7753 - acc: 0.8615 - val_loss: 3.4856 - val_acc: 0.7
414

Epoch 00164: val_acc did not improve from 0.82759
Epoch 165/250
157/157 [==============================] - 1s 9ms/step - loss: 2.4070 - acc: 0.8344 - val_loss: 3.0437 - val_acc: 0.7
586

Epoch 00165: val_acc did not improve from 0.82759
Epoch 166/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5020 - acc: 0.8710 - val_loss: 2.8248 - val_acc: 0.7
414
```

```
Epoch 00166: val_acc did not improve from 0.82759
Epoch 167/250
157/157 [==============================] - 2s 10ms/step - loss: 2.7612 - acc: 0.8153 - val_loss: 3.8857 - val_acc: 0.
6897

Epoch 00167: val_acc did not improve from 0.82759
Epoch 168/250
157/157 [==============================] - 2s 10ms/step - loss: 1.8731 - acc: 0.8471 - val_loss: 2.5407 - val_acc: 0.
7759

Epoch 00168: val_acc did not improve from 0.82759
Epoch 169/250
157/157 [==============================] - 1s 9ms/step - loss: 1.8649 - acc: 0.8439 - val_loss: 3.4920 - val_acc: 0.6
034

Epoch 00169: val_acc did not improve from 0.82759
Epoch 170/250
157/157 [==============================] - 1s 9ms/step - loss: 2.8232 - acc: 0.7898 - val_loss: 2.6707 - val_acc: 0.6
379

Epoch 00170: val_acc did not improve from 0.82759
Epoch 171/250
157/157 [==============================] - 1s 9ms/step - loss: 1.7210 - acc: 0.8583 - val_loss: 2.5053 - val_acc: 0.7
241

Epoch 00171: val_acc did not improve from 0.82759
Epoch 172/250
157/157 [==============================] - 1s 9ms/step - loss: 1.6885 - acc: 0.8583 - val_loss: 2.5858 - val_acc: 0.6
897

Epoch 00172: val_acc did not improve from 0.82759
Epoch 173/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0425 - acc: 0.8806 - val_loss: 1.0328 - val_acc: 0.7
931

Epoch 00173: val_acc did not improve from 0.82759
Epoch 174/250
157/157 [==============================] - 1s 9ms/step - loss: 1.8359 - acc: 0.8264 - val_loss: 2.2658 - val_acc: 0.7
414

Epoch 00174: val_acc did not improve from 0.82759
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Epoch 175/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4423 - acc: 0.8583 - val_loss: 1.9929 - val_acc: 0.7
759

Epoch 00175: val_acc did not improve from 0.82759
Epoch 176/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4696 - acc: 0.8551 - val_loss: 3.5034 - val_acc: 0.6
897

Epoch 00176: val_acc did not improve from 0.82759
Epoch 177/250
157/157 [==============================] - 1s 9ms/step - loss: 2.0347 - acc: 0.8408 - val_loss: 5.2629 - val_acc: 0.5
345

Epoch 00177: val_acc did not improve from 0.82759
Epoch 178/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5551 - acc: 0.8089 - val_loss: 1.6471 - val_acc: 0.5
862

Epoch 00178: val_acc did not improve from 0.82759
Epoch 179/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5413 - acc: 0.8647 - val_loss: 5.1735 - val_acc: 0.6
207

Epoch 00179: val_acc did not improve from 0.82759
Epoch 180/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5903 - acc: 0.8280 - val_loss: 1.5157 - val_acc: 0.5
517

Epoch 00180: val_acc did not improve from 0.82759
Epoch 181/250
157/157 [==============================] - 1s 9ms/step - loss: 2.3028 - acc: 0.8105 - val_loss: 4.2983 - val_acc: 0.6
897

Epoch 00181: val_acc did not improve from 0.82759
Epoch 182/250
157/157 [==============================] - 1s 9ms/step - loss: 2.8803 - acc: 0.8057 - val_loss: 3.9221 - val_acc: 0.6
724

Epoch 00182: val_acc did not improve from 0.82759
Epoch 183/250
157/157 [==============================] - 1s 9ms/step - loss: 1.8662 - acc: 0.8694 - val_loss: 2.6756 - val_acc: 0.7
```

241

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Epoch 00183: val_acc did not improve from 0.82759
Epoch 184/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2924 - acc: 0.8854 - val_loss: 3.3143 - val_acc: 0.6
552

Epoch 00184: val_acc did not improve from 0.82759
Epoch 185/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5650 - acc: 0.8105 - val_loss: 1.9074 - val_acc: 0.6
379

Epoch 00185: val_acc did not improve from 0.82759
Epoch 186/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4609 - acc: 0.8424 - val_loss: 2.6708 - val_acc: 0.6
724

Epoch 00186: val_acc did not improve from 0.82759
Epoch 187/250
157/157 [==============================] - 1s 9ms/step - loss: 1.7171 - acc: 0.8392 - val_loss: 4.4454 - val_acc: 0.6
034

Epoch 00187: val_acc did not improve from 0.82759
Epoch 188/250
157/157 [==============================] - 1s 9ms/step - loss: 1.9449 - acc: 0.8487 - val_loss: 2.9223 - val_acc: 0.6
897

Epoch 00188: val_acc did not improve from 0.82759
Epoch 189/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5835 - acc: 0.8519 - val_loss: 1.5951 - val_acc: 0.6
552

Epoch 00189: val_acc did not improve from 0.82759
Epoch 190/250
157/157 [==============================] - 1s 9ms/step - loss: 1.7601 - acc: 0.8503 - val_loss: 2.9119 - val_acc: 0.6
724

Epoch 00190: val_acc did not improve from 0.82759
Epoch 191/250
157/157 [==============================] - 1s 9ms/step - loss: 1.0008 - acc: 0.8790 - val_loss: 2.0589 - val_acc: 0.6
552
```

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Epoch 00191: val_acc did not improve from 0.82759
Epoch 192/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5698 - acc: 0.8137 - val_loss: 2.8223 - val_acc: 0.6
724


Epoch 00192: val_acc did not improve from 0.82759
Epoch 193/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5270 - acc: 0.8232 - val_loss: 3.2041 - val_acc: 0.6
034


Epoch 00193: val_acc did not improve from 0.82759
Epoch 194/250
157/157 [==============================] - 1s 9ms/step - loss: 1.9169 - acc: 0.6529 - val_loss: 2.3617 - val_acc: 0.7
069


Epoch 00194: val_acc did not improve from 0.82759
Epoch 195/250
157/157 [==============================] - 1s 9ms/step - loss: 1.2741 - acc: 0.8551 - val_loss: 1.5572 - val_acc: 0.6
724


Epoch 00195: val_acc did not improve from 0.82759
Epoch 196/250
157/157 [==============================] - 1s 9ms/step - loss: 1.4216 - acc: 0.8455 - val_loss: 3.4535 - val_acc: 0.6
724


Epoch 00196: val_acc did not improve from 0.82759
Epoch 197/250
157/157 [==============================] - 1s 9ms/step - loss: 1.3626 - acc: 0.7978 - val_loss: 3.2209 - val_acc: 0.6
724


Epoch 00197: val_acc did not improve from 0.82759
Epoch 198/250
157/157 [==============================] - 1s 9ms/step - loss: 3.3774 - acc: 0.7707 - val_loss: 5.3511 - val_acc: 0.6
207


Epoch 00198: val_acc did not improve from 0.82759
Epoch 199/250
157/157 [==============================] - 1s 9ms/step - loss: 2.0393 - acc: 0.8440 - val_loss: 2.7418 - val_acc: 0.7
759


Epoch 00199: val_acc did not improve from 0.82759
Epoch 200/250
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157/157 [==============================] - 1s 9ms/step - loss: 1.9777 - acc: 0.8615 - val_loss: 2.5107 - val_acc: 0.7
586

Epoch 00200: val_acc did not improve from 0.82759
Epoch 201/250
157/157 [==============================] - 1s 9ms/step - loss: 1.8675 - acc: 0.8105 - val_loss: 2.3402 - val_acc: 0.7
414

Epoch 00201: val_acc did not improve from 0.82759
Epoch 202/250
157/157 [==============================] - 1s 9ms/step - loss: 1.5981 - acc: 0.7898 - val_loss: 3.1567 - val_acc: 0.7
069

Epoch 00202: val_acc did not improve from 0.82759
Epoch 203/250
157/157 [==============================] - 1s 9ms/step - loss: 1.1035 - acc: 0.8806 - val_loss: 0.7995 - val_acc: 0.7
931

Epoch 00203: val_acc did not improve from 0.82759
Epoch 204/250
157/157 [==============================] - 1s 9ms/step - loss: 1.9444 - acc: 0.7468 - val_loss: 2.3010 - val_acc: 0.5
000

Epoch 00204: val_acc did not improve from 0.82759
Epoch 205/250
157/157 [==============================] - 1s 9ms/step - loss: 2.4980 - acc: 0.7771 - val_loss: 4.2822 - val_acc: 0.6
897

Epoch 00205: val_acc did not improve from 0.82759
Epoch 206/250
157/157 [==============================] - 1s 9ms/step - loss: 3.9206 - acc: 0.7357 - val_loss: 4.1844 - val_acc: 0.7
241

Epoch 00206: val_acc did not improve from 0.82759
Epoch 207/250
157/157 [==============================] - 1s 9ms/step - loss: 3.7692 - acc: 0.7564 - val_loss: 3.6823 - val_acc: 0.7
241

Epoch 00207: val_acc did not improve from 0.82759
Epoch 208/250
157/157 [==============================] - 1s 9ms/step - loss: 3.5722 - acc: 0.7675 - val_loss: 3.0953 - val_acc: 0.7
586
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        Epoch 00208: val_acc did not improve from 0.82759
        Epoch 209/250
        157/157 [==============================] - 1s 9ms/step - loss: 3.9562 - acc: 0.7452 - val_loss: 4.9700 - val_acc: 0.6
        552

        Epoch 00209: val_acc did not improve from 0.82759
        Epoch 210/250
        157/157 [==============================] - 1s 9ms/step - loss: 3.4806 - acc: 0.7723 - val_loss: 7.4478 - val_acc: 0.5
        172

        Epoch 00210: val_acc did not improve from 0.82759
        Epoch 211/250
        157/157 [==============================] - 1s 9ms/step - loss: 4.0567 - acc: 0.7261 - val_loss: 4.0470 - val_acc: 0.6
        379

        Epoch 00211: val_acc did not improve from 0.82759
        Epoch 212/250
        157/157 [==============================] - 1s 9ms/step - loss: 1.6689 - acc: 0.8726 - val_loss: 2.8063 - val_acc: 0.7
        069

        Epoch 00212: val_acc did not improve from 0.82759
        Epoch 213/250
        157/157 [==============================] - 1s 9ms/step - loss: 1.6424 - acc: 0.8806 - val_loss: 2.4186 - val_acc: 0.7
        241

        Epoch 00213: val_acc did not improve from 0.82759
        Epoch 214/250
        157/157 [==============================] - 1s 9ms/step - loss: 1.7585 - acc: 0.8344 - val_loss: 3.0410 - val_acc: 0.7
        241

        Epoch 00214: val_acc did not improve from 0.82759
        Epoch 215/250
        157/157 [==============================] - 1s 9ms/step - loss: 1.8680 - acc: 0.8535 - val_loss: 2.5605 - val_acc: 0.6
        379

        Epoch 00215: val_acc did not improve from 0.82759
        Epoch 216/250
        157/157 [==============================] - 1s 9ms/step - loss: 2.4411 - acc: 0.8217 - val_loss: 6.1617 - val_acc: 0.5
        172

        Epoch 00216: val_acc did not improve from 0.82759
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Epoch 217/250
157/157 [==============================] - 1s 9ms/step - loss: 3.6805 - acc: 0.7388 - val_loss: 3.8084 - val_acc: 0.6
724

Epoch 00217: val_acc did not improve from 0.82759
Epoch 218/250
157/157 [==============================] - 1s 9ms/step - loss: 2.0445 - acc: 0.7484 - val_loss: 2.6328 - val_acc: 0.5
345

Epoch 00218: val_acc did not improve from 0.82759
Epoch 219/250
157/157 [==============================] - 1s 9ms/step - loss: 3.1094 - acc: 0.6354 - val_loss: 1.8343 - val_acc: 0.3
966

Epoch 00219: val_acc did not improve from 0.82759
Epoch 220/250
157/157 [==============================] - 1s 9ms/step - loss: 2.9041 - acc: 0.6162 - val_loss: 6.0371 - val_acc: 0.4
828

Epoch 00220: val_acc did not improve from 0.82759
Epoch 221/250
157/157 [==============================] - 1s 9ms/step - loss: 2.8991 - acc: 0.7914 - val_loss: 3.8413 - val_acc: 0.7
241

Epoch 00221: val_acc did not improve from 0.82759
Epoch 222/250
157/157 [==============================] - 1s 9ms/step - loss: 4.6212 - acc: 0.7118 - val_loss: 5.5172 - val_acc: 0.6
379

Epoch 00222: val_acc did not improve from 0.82759
Epoch 223/250
157/157 [==============================] - 1s 9ms/step - loss: 3.7240 - acc: 0.7659 - val_loss: 7.1538 - val_acc: 0.5
172

Epoch 00223: val_acc did not improve from 0.82759
Epoch 224/250
157/157 [==============================] - 1s 9ms/step - loss: 3.3567 - acc: 0.7755 - val_loss: 3.9848 - val_acc: 0.7
241

Epoch 00224: val_acc did not improve from 0.82759
Epoch 225/250
157/157 [==============================] - 1s 9ms/step - loss: 3.0515 - acc: 0.7707 - val_loss: 4.2080 - val_acc: 0.6
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897

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Epoch 00225: val_acc did not improve from 0.82759
Epoch 226/250
157/157 [==============================] - 1s 9ms/step - loss: 2.4080 - acc: 0.8424 - val_loss: 3.9875 - val_acc: 0.7
414

Epoch 00226: val_acc did not improve from 0.82759
Epoch 227/250
157/157 [==============================] - 1s 9ms/step - loss: 4.4010 - acc: 0.7022 - val_loss: 5.2972 - val_acc: 0.6
552

Epoch 00227: val_acc did not improve from 0.82759
Epoch 228/250
157/157 [==============================] - 1s 9ms/step - loss: 4.1978 - acc: 0.7245 - val_loss: 9.4486 - val_acc: 0.4
138

Epoch 00228: val_acc did not improve from 0.82759
Epoch 229/250
157/157 [==============================] - 1s 9ms/step - loss: 9.6940 - acc: 0.3965 - val_loss: 10.0043 - val_acc: 0.
3793

Epoch 00229: val_acc did not improve from 0.82759
Epoch 230/250
157/157 [==============================] - 1s 9ms/step - loss: 4.9600 - acc: 0.6879 - val_loss: 4.8489 - val_acc: 0.6
897

Epoch 00230: val_acc did not improve from 0.82759
Epoch 231/250
157/157 [==============================] - 1s 9ms/step - loss: 3.2901 - acc: 0.7882 - val_loss: 5.7707 - val_acc: 0.6
207

Epoch 00231: val_acc did not improve from 0.82759
Epoch 232/250
157/157 [==============================] - 1s 9ms/step - loss: 4.3873 - acc: 0.7197 - val_loss: 5.5417 - val_acc: 0.6
207

Epoch 00232: val_acc did not improve from 0.82759
Epoch 233/250
157/157 [==============================] - 1s 9ms/step - loss: 5.6899 - acc: 0.6449 - val_loss: 7.4237 - val_acc: 0.5
345
```

```
Epoch 00233: val_acc did not improve from 0.82759
Epoch 234/250
157/157 [==============================] - 1s 9ms/step - loss: 3.7541 - acc: 0.7659 - val_loss: 6.3612 - val_acc: 0.5
862


Epoch 00234: val_acc did not improve from 0.82759
Epoch 235/250
157/157 [==============================] - 1s 9ms/step - loss: 4.3526 - acc: 0.7261 - val_loss: 6.2791 - val_acc: 0.6
034


Epoch 00235: val_acc did not improve from 0.82759
Epoch 236/250
157/157 [==============================] - 1s 9ms/step - loss: 5.6159 - acc: 0.6433 - val_loss: 6.3917 - val_acc: 0.6
034


Epoch 00236: val_acc did not improve from 0.82759
Epoch 237/250
157/157 [==============================] - 1s 9ms/step - loss: 6.1135 - acc: 0.6178 - val_loss: 10.5601 - val_acc: 0.
3448


Epoch 00237: val_acc did not improve from 0.82759
Epoch 238/250
157/157 [==============================] - 1s 9ms/step - loss: 5.5826 - acc: 0.6449 - val_loss: 10.8380 - val_acc: 0.
3276


Epoch 00238: val_acc did not improve from 0.82759
Epoch 239/250
157/157 [==============================] - 1s 9ms/step - loss: 8.5889 - acc: 0.4666 - val_loss: 9.7264 - val_acc: 0.3
966


Epoch 00239: val_acc did not improve from 0.82759
Epoch 240/250
157/157 [==============================] - 1s 9ms/step - loss: 7.5710 - acc: 0.5239 - val_loss: 8.3894 - val_acc: 0.4
483


Epoch 00240: val_acc did not improve from 0.82759
Epoch 241/250
157/157 [==============================] - 1s 9ms/step - loss: 3.8706 - acc: 0.7564 - val_loss: 6.1570 - val_acc: 0.5
862


Epoch 00241: val_acc did not improve from 0.82759
Epoch 242/250
```

```
157/157 [==============================] - 1s 9ms/step - loss: 3.0087 - acc: 0.7882 - val_loss: 4.9042 - val_acc: 0.5
517

Epoch 00242: val_acc did not improve from 0.82759
Epoch 243/250
157/157 [==============================] - 1s 9ms/step - loss: 2.9312 - acc: 0.3662 - val_loss: 2.4307 - val_acc: 0.0
690

Epoch 00243: val_acc did not improve from 0.82759
Epoch 244/250
157/157 [==============================] - 1s 9ms/step - loss: 2.5249 - acc: 0.1067 - val_loss: 2.3169 - val_acc: 0.1
552

Epoch 00244: val_acc did not improve from 0.82759
Epoch 245/250
157/157 [==============================] - 1s 9ms/step - loss: 2.4517 - acc: 0.1019 - val_loss: 2.2863 - val_acc: 0.1
552

Epoch 00245: val_acc did not improve from 0.82759
Epoch 246/250
157/157 [==============================] - 1s 9ms/step - loss: 2.3555 - acc: 0.0924 - val_loss: 2.2836 - val_acc: 0.1
552

Epoch 00246: val_acc did not improve from 0.82759
Epoch 247/250
157/157 [==============================] - 1s 9ms/step - loss: 2.3128 - acc: 0.1099 - val_loss: 2.2832 - val_acc: 0.1
552

Epoch 00247: val_acc did not improve from 0.82759
Epoch 248/250
157/157 [==============================] - 1s 9ms/step - loss: 2.4574 - acc: 0.1067 - val_loss: 2.2591 - val_acc: 0.2
069

Epoch 00248: val_acc did not improve from 0.82759
Epoch 249/250
157/157 [==============================] - 1s 9ms/step - loss: 2.3473 - acc: 0.1083 - val_loss: 2.2949 - val_acc: 0.1
552

Epoch 00249: val_acc did not improve from 0.82759
Epoch 250/250
157/157 [==============================] - 1s 9ms/step - loss: 2.6004 - acc: 0.1003 - val_loss: 2.2988 - val_acc: 0.1
897
```

```
Epoch 00250: val_acc did not improve from 0.82759
```

In [14]:
```python
sns.set()
plt.plot(history.history['acc'], 'r')
plt.plot(history.history['val_acc'], 'b')
plt.legend({'Train Accuracy': 'r', 'Test Accuracy':'b'})
plt.show()
plt.plot(history.history['loss'], 'r')
plt.plot(history.history['val_loss'], 'b')
plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
plt.show()
```
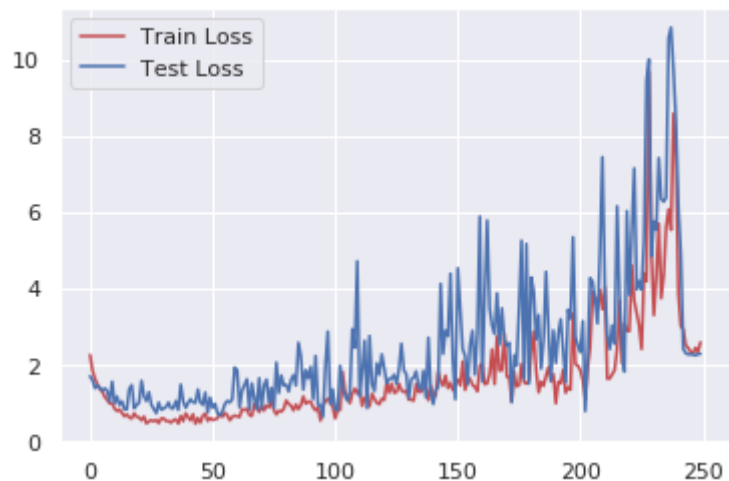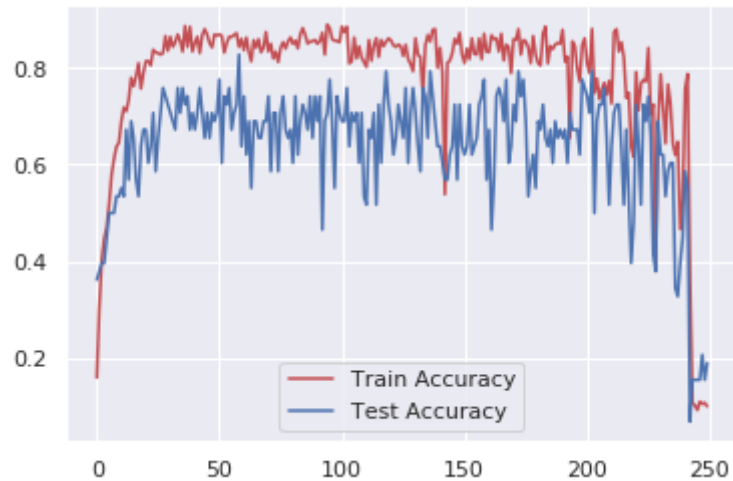
```
In [0]: %load_ext tensorboard
```

```
In [16]: %tensorboard --logdir '/content/drive/My Drive/Leaf Disease Classification/Results/Results-Segmented/graph_31'
```

Output hidden; open in https://colab.research.google.com to view.

```
In [0]: model.load_weights(path+'Results/Results-Segmented/model_31.h5')
```

```
In [22]: y_pred_tr = model.predict(X_train)

y_tr2 = y_train.argmax(1)
y_pred_tr = y_pred_tr.argmax(1)

train_acc = accuracy_score(y_tr2, y_pred_tr)
print("Train Accuracy : ", train_acc)
```

Train Accuracy : 0.9619047619047619

```
In [21]: y_pred = model.predict(X_test)

y_te2 = y_test.argmax(1)
y_pred = y_pred.argmax(1)

test_acc = accuracy_score(y_te2, y_pred)
print("Test Accuracy : ", test_acc)
```
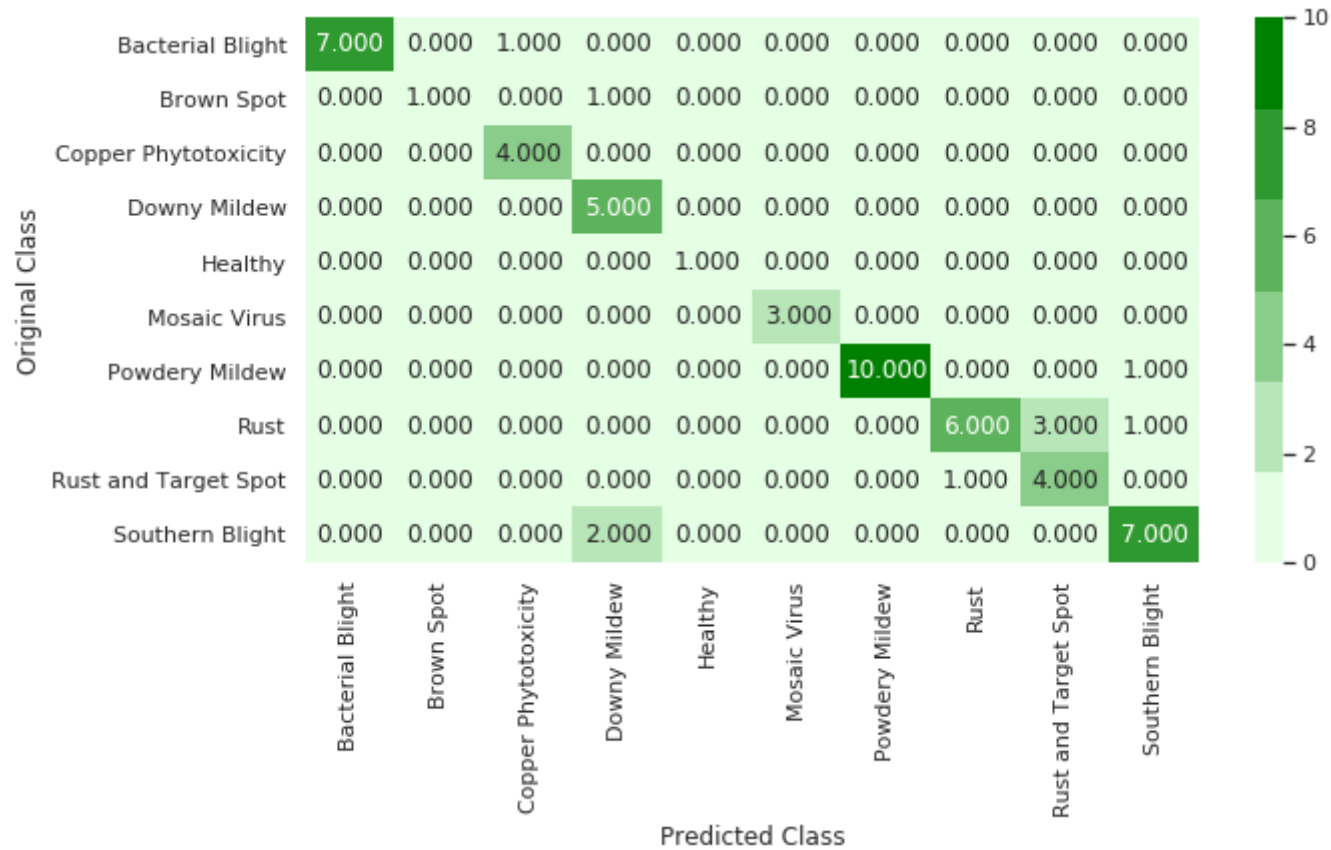
Test Accuracy : 0.8275862068965517

In [20]: `plot_confusion_matrix(test_y=y_te2, predict_y=y_pred, labels=folders)`
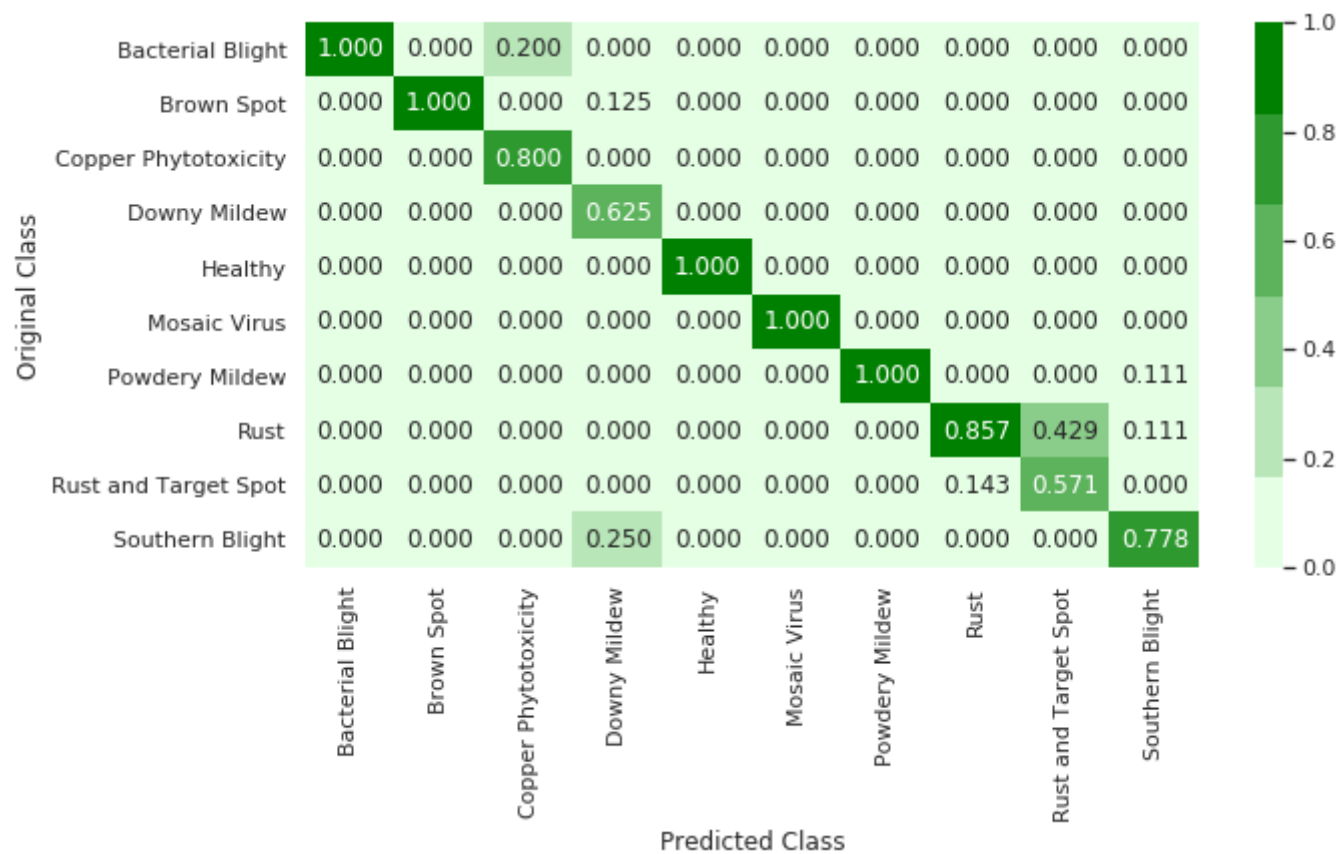
```
Number of misclassified points  17.24137931034483
```

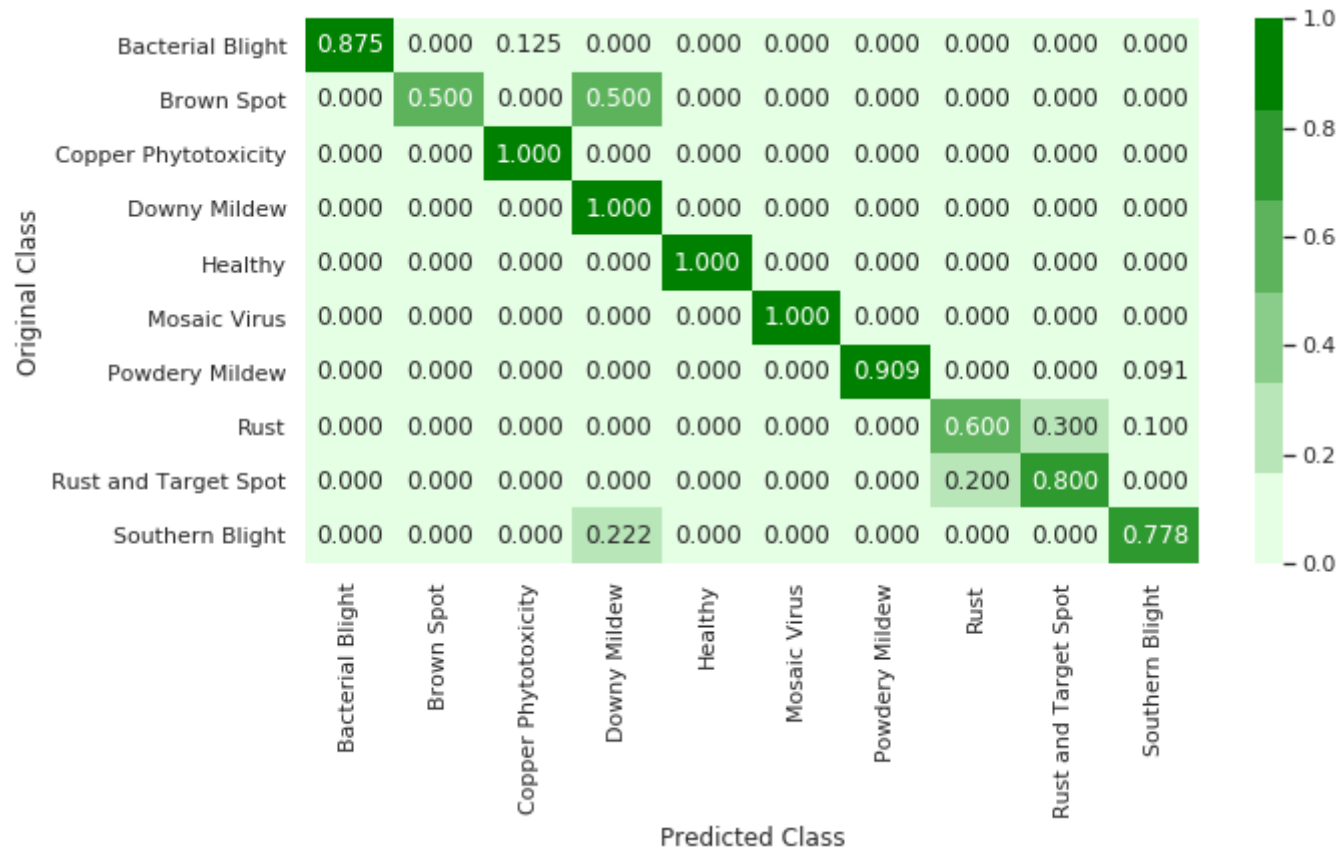-- Confusion matrix --
-

-- Precision matrix --
-

```
Sum of columns in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]
--------------------------------------------------- Recall matrix ---------------------------------------------------
```

Sum of rows in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

5. Results

- We have experimented two different cnn model architectures on original, cropped and segmented datasets.
- The results obtained from the above models are provided in below table.

In [22]:
```python
# Please compare all your models using Prettytable library
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ["Dataset Type", "CNN Model", "Train Accuracy", "Test Accuracy" ]
x.add_row(["Original Images", "Model 1 ", 97.3015, 84.4827])
x.add_row(["Original Images", "Model 2", 96.5079, 77.5862 ])
x.add_row(["Cropped Images", "Model 1", 49.2063, 65.5172 ])
x.add_row(["Cropped Images", "Model 2", 98.7301, 81.0344])
x.add_row(["Segmented Images", "Model 1", 18.2539, 24.1379 ])
x.add_row(["Segmented Images", "Model 2", 96.1905, 82.7586 ])

print(x)
```

```
+------------------+-----------+----------------+---------------+
|   Dataset Type   | CNN Model | Train Accuracy | Test Accuracy |
+------------------+-----------+----------------+---------------+
| Original Images  |  Model 1  |    97.3015     |    84.4827    |
| Original Images  |  Model 2  |    96.5079     |    77.5862    |
|  Cropped Images  |  Model 1  |    49.2063     |    65.5172    |
|  Cropped Images  |  Model 2  |    98.7301     |    81.0344    |
| Segmented Images |  Model 1  |    18.2539     |    24.1379    |
| Segmented Images |  Model 2  |    96.1905     |    82.7586    |
+------------------+-----------+----------------+---------------+
```

6. Conclusions

1. In this case study, two different CNN architectures are built on original, cropped and segmented soyabean leaf images.
2. Since, dataset is too small, data augmentation is performed.
3. Due to highly imbalanced dataset, upsampling techniques are used.
4. Because of small and highly imbalanced dataset, the performance of models on some datasets are poor.
5. Both model1 and model2 gave good results for original images.
6. From, confusion, precision and recall matrices, it is observed that 'Rust' and 'Rust and Target Spot' classes are misclassified because images of these classes are mostly similar.
7. And also it is observed that some classes have high variance in colors for images belonging to same class. Due to this, achieving best results is difficult.
8. Although, dataset is very small and highly imbalanced, better results are achieved in following cases:
   - Model 1 - Original Images
   - Model 2 - Segmented and Cropped Images
9. Because of dataset structure, best model cannot be justified. But, among all models, model 1 on original images is the best.
10. CNN Models on original images have given better performance than cropped images and segmented images.
11. If dataset is large, the performance of the models might further improve.
12. It seems that image segmentation technique might also give better results for larger results.