

Artificial Intelligence Nanodegree

Convolutional Neural Networks

Project: Write an Algorithm for a Dog Identification App

In this notebook, some template code has already been provided for you, and you will need to implement additional functionality to successfully complete this project. You will not need to modify the included code beyond what is requested. Sections that begin with **'(IMPLEMENTATION)'** in the header indicate that the following block of code will require additional functionality which you must provide. Instructions will be provided for each section, and the specifics of the implementation are marked in the code block with a 'TODO' statement. Please be sure to read the instructions carefully!

Note: Once you have completed all of the code implementations, you need to finalize your work by exporting the iPython Notebook as an HTML document. Before exporting the notebook to html, all of the code cells need to have been run so that reviewers can see the final implementation and output. You can then export the notebook by using the menu above and navigating to \n", **"File -> Download as -> HTML (.html)**. Include the finished document along with this notebook as your submission.

In addition to implementing code, there will be questions that you must answer which relate to the project and your implementation. Each section where you will answer a question is preceded by a **'Question X'** header. Carefully read each question and provide thorough answers in the following text boxes that begin with **'Answer:'**. Your project submission will be evaluated based on your answers to each of the questions and the implementation you provide.

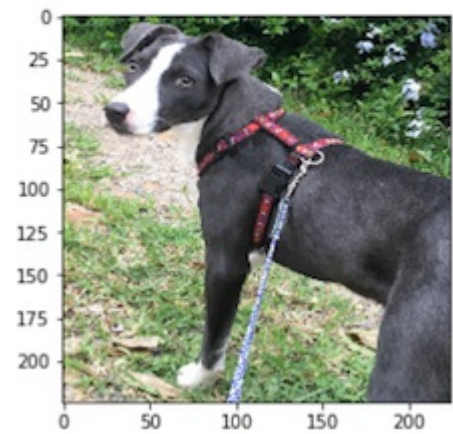
Note: Code and Markdown cells can be executed using the **Shift + Enter** keyboard shortcut. Markdown cells can be edited by double-clicking the cell to enter edit mode.

The rubric contains *optional* "Stand Out Suggestions" for enhancing the project beyond the minimum requirements. If you decide to pursue the "Stand Out Suggestions", you should include the code in this IPython notebook.

Why We're Here

In this notebook, you will make the first steps towards developing an algorithm that could be used as part of a mobile or web app. At the end of this project, your code will accept any user-supplied image as input. If a dog is detected in the image, it will provide an estimate of the dog's breed. If a human is detected, it will provide an estimate of the dog breed that is most resembling. The image below displays potential sample output of your finished project (... but we expect that each student's algorithm will behave differently!).

```
hello, dog!  
your predicted breed is ...  
American Staffordshire terrier
```



In this real-world setting, you will need to piece together a series of models to perform different tasks; for instance, the algorithm that detects humans in an image will be different from the CNN that infers dog breed. There are many points of possible failure, and no perfect algorithm exists. Your imperfect solution will nonetheless create a fun user experience!

The Road Ahead

We break the notebook into separate steps. Feel free to use the links below to navigate the notebook.

- [Step 0: Import Datasets](#)
- [Step 1: Detect Humans](#)
- [Step 2: Detect Dogs](#)
- [Step 3: Create a CNN to Classify Dog Breeds \(from Scratch\)](#)
- [Step 4: Use a CNN to Classify Dog Breeds \(using Transfer Learning\)](#)
- [Step 5: Create a CNN to Classify Dog Breeds \(using Transfer Learning\)](#)
- [Step 6: Write your Algorithm](#)
- [Step 7: Test Your Algorithm](#)

Step 0: Import Datasets

Import Dog Dataset

In the code cell below, we import a dataset of dog images. We populate a few variables through the use of the `load_files` function from the scikit-learn library:

- `train_files`, `valid_files`, `test_files` - numpy arrays containing file paths to images
- `train_targets`, `valid_targets`, `test_targets` - numpy arrays containing onehot-encoded classification labels
- `dog_names` - list of string-valued dog breed names for translating labels

```
from sklearn.datasets import load_files
from keras.utils import np_utils
import numpy as np
from glob import glob

# define function to load train, test, and validation datasets
def load_dataset(path):
    data = load_files(path)
    dog_files = np.array(data['filenames'])
    dog_targets = np_utils.to_categorical(np.array(data['target']), 133)
    return dog_files, dog_targets

# load train, test, and validation datasets
train_files, train_targets = load_dataset('dogImages/train')
valid_files, valid_targets = load_dataset('dogImages/valid')
test_files, test_targets = load_dataset('dogImages/test')

# load list of dog names
dog_names = [item[20:-1] for item in sorted(glob("dogImages/train/*/"))]

# print statistics about the dataset
print('There are %d total dog categories.' % len(dog_names))
print('There are %s total dog images.\n' % len(np.hstack([train_files, valid_files, test_files])))
print('There are %d training dog images.' % len(train_files))
print('There are %d validation dog images.' % len(valid_files))
print('There are %d test dog images.' % len(test_files))
```

```
Using TensorFlow backend.
```

```
There are 133 total dog categories.  
There are 8351 total dog images.
```

```
There are 6680 training dog images.  
There are 835 validation dog images.  
There are 836 test dog images.
```

Import Human Dataset

In the code cell below, we import a dataset of human images, where the file paths are stored in the numpy array `human_files`.

```
import random  
random.seed(8675309)  
  
# load filenames in shuffled human dataset  
human_files = np.array(glob("lfw/*/"))  
random.shuffle(human_files)  
  
# print statistics about the dataset  
print('There are %d total human images.' % len(human_files))
```

```
There are 13233 total human images.
```

Step 1: Detect Humans

We use OpenCV's implementation of [Haar feature-based cascade classifiers](#) to detect human faces in images. OpenCV provides many pre-trained face detectors, stored as XML files on [github](#). We have downloaded one of these detectors and stored it in the `haarcascades` directory.

In the next code cell, we demonstrate how to use this detector to find human faces in a sample image.

```
import cv2  
import matplotlib.pyplot as plt  
%matplotlib inline  
  
# extract pre-trained face detector  
face_cascade = cv2.CascadeClassifier('haarcascades/haarcascade_frontalface_alt.xml')  
  
# load color (BGR) image  
img = cv2.imread(human_files[3])  
# convert BGR image to grayscale
```

```

gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

# find faces in image
faces = face_cascade.detectMultiScale(gray)

# print number of faces detected in the image
print('Number of faces detected:', len(faces))

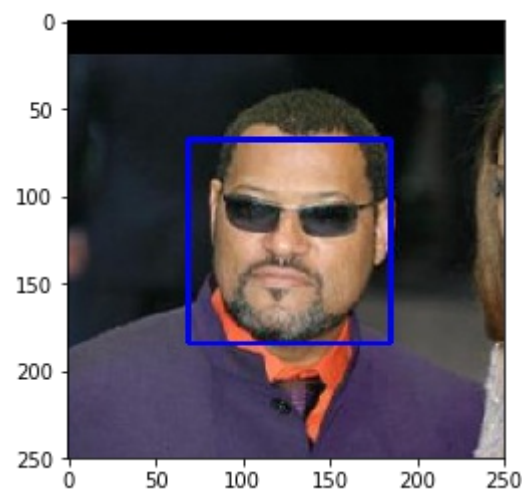
# get bounding box for each detected face
for (x,y,w,h) in faces:
    # add bounding box to color image
    cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)

# convert BGR image to RGB for plotting
cv_rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

# display the image, along with bounding box
plt.imshow(cv_rgb)
plt.show()

```

Number of faces detected: 1



Before using any of the face detectors, it is standard procedure to convert the images to grayscale. The `detectMultiScale` function executes the classifier stored in `face_cascade` and takes the grayscale image as a parameter.

In the above code, `faces` is a numpy array of detected faces, where each row corresponds to a detected face. Each detected face is a 1D array with four entries that specifies the bounding box of the detected face. The first two entries in the array (extracted in the above code as `x` and `y`) specify the horizontal and vertical positions of the top left corner of the bounding box. The last two entries in the array (extracted here as `w` and `h`) specify the width and height of the box.

Write a Human Face Detector

We can use this procedure to write a function that returns `True` if a human face is detected in an image and `False` otherwise. This function, aptly named `face_detector`, takes a string-valued file path to an image as input and appears in the code block below.

```

# returns "True" if face is detected in image stored at img_path

```

```
def face_detector(img_path):
    img = cv2.imread(img_path)
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    faces = face_cascade.detectMultiScale(gray)
    return len(faces) > 0
```

(IMPLEMENTATION) Assess the Human Face Detector

Question 1: Use the code cell below to test the performance of the `face_detector` function.

- What percentage of the first 100 images in `human_files` have a detected human face?
- What percentage of the first 100 images in `dog_files` have a detected human face?

Ideally, we would like 100% of human images with a detected face and 0% of dog images with a detected face. You will see that our algorithm falls short of this goal, but still gives acceptable performance. We extract the file paths for the first 100 images from each of the datasets and store them in the numpy arrays `human_files_short` and `dog_files_short`.

Answer:

- 99% in my case correctly classified in the dataset for humans, very good result
- 11% in my case miscassified as human in the dataset for dogs, should be better

```
human_files_short = human_files[:100]
dog_files_short = train_files[:100]
# Do NOT modify the code above this line.

## TODO: Test the performance of the face_detector algorithm
## on the images in human_files_short and dog_files_short.

# helper func
getPercentage = lambda Count, Total: (Count / Total) * 100
getLength = lambda List: len(List)

# func get percentage of human in the human list
def getPercentageOfHuman():
    count = 0
    for img in human_files_short:
        if face_detector(img):
            count += 1
    return getPercentage(count, getLength(human_files_short))

# func get percentage of human in the dog list
def getPercentageOfHumanAsDog():
    count = 0
    for img in dog_files_short:
        if face_detector(img):
            count += 1
    return getPercentage(count, getLength(dog_files_short))

print('Results are:')
print('{}% Percentage of humans correctly classified'.format(getPercentageOfHuman()))
```

```
print('{}% Percentage of dogs misclassified as human:'.format(getPercentageOfHumanAsDog()))
```

Results are:

99.0% Percentage of humans correctly classified
11.0% Percentage of dogs misclassified as human:

Question 2: This algorithmic choice necessitates that we communicate to the user that we accept human images only when they provide a clear view of a face (otherwise, we risk having unnecessarily frustrated users!). In your opinion, is this a reasonable expectation to pose on the user? If not, can you think of a way to detect humans in images that does not necessitate an image with a clearly presented face?

Answer:

- Head pictures in different angles
- 3D head model
- Side picture of the ear and nose

We suggest the face detector from OpenCV as a potential way to detect human images in your algorithm, but you are free to explore other approaches, especially approaches that make use of deep learning 😊. Please use the code cell below to design and test your own face detection algorithm. If you decide to pursue this *optional* task, report performance on each of the datasets.

```
## (Optional) TODO: Report the performance of another  
## face detection algorithm on the LFW dataset  
### Feel free to use as many code cells as needed.
```

```
import cv2  
import matplotlib.pyplot as plt  
%matplotlib inline  
  
# extract pre-trained face detector  
face_cascade = cv2.CascadeClassifier('haarcascades/haarcascade_frontalface_alt.xml')  
# smile_cascade = cv2.CascadeClassifier('haarcascades/haarcascade_smile.xml')  
eye_cascade = cv2.CascadeClassifier('haarcascades/haarcascade_eye.xml')  
  
# load color (BGR) image  
img = cv2.imread(human_files[3])  
# convert BGR image to grayscale  
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)  
  
# find faces in image  
faces = face_cascade.detectMultiScale(gray)  
  
# find smiles  
# smiles = smile_cascade.detectMultiScale(gray)  
# print('Number of smiles detected:', len(smiles))  
# for (ex,ey,ew,eh) in smiles:  
#     cv2.rectangle(img,(ex,ey),(ex+ew,ey+eh),(0,255,0),2)
```

```

# find eye
eyes = eye_cascade.detectMultiScale(gray)
print('Number of eyes detected:', len(eyes))
for (ex,ey,ew,eh) in eyes:
    cv2.rectangle(img,(ex,ey),(ex+ew,ey+eh),(0,255,0),2)

# print number of faces detected in the image
print('Number of faces detected:', len(faces))

# get bounding box for each detected face
for (x,y,w,h) in faces:
    # add bounding box to color image
    cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)

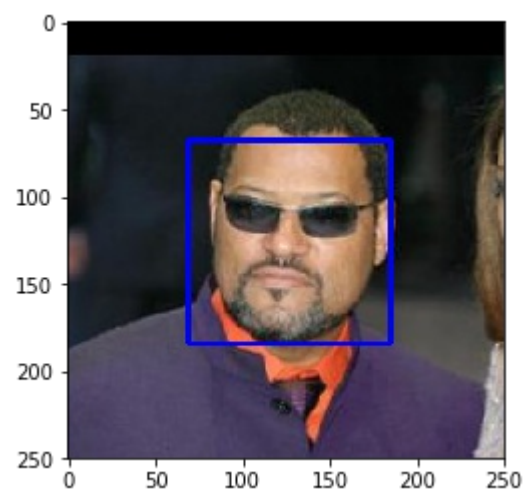
# convert BGR image to RGB for plotting
cv_rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

# display the image, along with bounding box
plt.imshow(cv_rgb)
plt.show()

print('Results are:')
print('{}% Percentage of humans correctly classified'.format(getPercentageOfHuman()))
print('{}% Percentage of dogs misclassified as human:'.format(getPercentageOfHumanAsDog()))

```

Number of eyes detected: 0
Number of faces detected: 1



Results are:
99.0% Percentage of humans correctly classified
11.0% Percentage of dogs misclassified as human:

Interesting observation with eyes detection algorithm

- With sun glasses the eyes are not detected/classified

I do not change the image of Laurence Fishburn, no chance....that's a sign!

I quote Laurence Fishburn:

This your last chance. After this there is no turning back. You take the blue pill, the story ends. You wake up in your bed and believe whatever you want to. You take the red pill, you stay in Wonderland, and I show you how deep the rabbit hole goes. Remember, all I'm offering is the truth. Nothing more.

I take the red pill and stay in Deep Learning Wonderland....

Step 2: Detect Dogs

In this section, we use a pre-trained [ResNet-50](#) model to detect dogs in images. Our first line of code downloads the ResNet-50 model, along with weights that have been trained on [ImageNet](#), a very large, very popular dataset used for image classification and other vision tasks. ImageNet contains over 10 million URLs, each linking to an image containing an object from one of [1000 categories](#). Given an image, this pre-trained ResNet-50 model returns a prediction (derived from the available categories in ImageNet) for the object that is contained in the image.

```
from keras.applications.resnet50 import ResNet50

# define ResNet50 model
ResNet50_model = ResNet50(weights='imagenet')
```

Pre-process the Data

When using TensorFlow as backend, Keras CNNs require a 4D array (which we'll also refer to as a 4D tensor) as input, with shape

$(\text{nb_samples}, \text{rows}, \text{columns}, \text{channels})$, $$$$$

where **nb_samples** corresponds to the total number of images (or samples), and **rows**, **columns**, and **channels** correspond to the number of rows, columns, and channels for each image, respectively.

The **path_to_tensor** function below takes a string-valued file path to a color image as input and returns a 4D tensor suitable for supplying to a Keras CNN. The function first loads the image and resizes it to a square image that is 224×224 pixels. Next, the image is converted to an array, which is then resized to a 4D tensor. In this case, since we are working with color images, each image has three channels. Likewise, since we are processing a single image (or sample), the returned tensor will always have shape

$$$$ (1, 224, 224, 3). $$$$

The **paths_to_tensor** function takes a numpy array of string-valued image paths as input and returns a 4D tensor with shape

$$$$ (\text{nb_samples}, 224, 224, 3). $$$$

Here, **nb_samples** is the number of samples, or number of images, in the supplied array of image paths. It is best to think of **nb_samples** as the number of 3D tensors (where each 3D tensor corresponds to a different image) in your dataset!

```
from keras.preprocessing import image
from tqdm import tqdm

def path_to_tensor(img_path):
```



```
# loads RGB image as PIL.Image.Image type
img = image.load_img(img_path, target_size=(224, 224))
# convert PIL.Image.Image type to 3D tensor with shape (224, 224, 3)
x = image.img_to_array(img)
# convert 3D tensor to 4D tensor with shape (1, 224, 224, 3) and return 4D tensor
return np.expand_dims(x, axis=0)

def paths_to_tensor(img_paths):
    list_of_tensors = [path_to_tensor(img_path) for img_path in tqdm(img_paths)]
    return np.vstack(list_of_tensors)
```

Making Predictions with ResNet-50

Getting the 4D tensor ready for ResNet-50, and for any other pre-trained model in Keras, requires some additional processing. First, the RGB image is converted to BGR by reordering the channels. All pre-trained models have the additional normalization step that the mean pixel (expressed in RGB as $[103.939, 116.779, 123.68]$ and calculated from all pixels in all images in ImageNet) must be subtracted from every pixel in each image. This is implemented in the imported function `preprocess_input`. If you're curious, you can check the code for `preprocess_input` [here](#).

Now that we have a way to format our image for supplying to ResNet-50, we are now ready to use the model to extract the predictions. This is accomplished with the `predict` method, which returns an array whose i -th entry is the model's predicted probability that the image belongs to the i -th ImageNet category. This is implemented in the `ResNet50_predict_labels` function below.

By taking the argmax of the predicted probability vector, we obtain an integer corresponding to the model's predicted object class, which we can identify with an object category through the use of this [dictionary](#).

```
from keras.applications.resnet50 import preprocess_input, decode_predictions

def ResNet50_predict_labels(img_path):
    # returns prediction vector for image located at img_path
    img = preprocess_input(path_to_tensor(img_path))
    return np.argmax(ResNet50_model.predict(img))
```

Write a Dog Detector

While looking at the [dictionary](#), you will notice that the categories corresponding to dogs appear in an uninterrupted sequence and correspond to dictionary keys 151-268, inclusive, to include all categories from 'Chihuahua' to 'Mexican hairless'. Thus, in order to check to see if an image is predicted to contain a dog by the pre-trained ResNet-50 model, we need only check if the `ResNet50_predict_labels` function above returns a value between 151 and 268 (inclusive).

We use these ideas to complete the `dog_detector` function below, which returns `True` if a dog is detected in an image (and `False` if not).

```
### returns "True" if a dog is detected in the image stored at img_path
def dog_detector(img_path):
    prediction = ResNet50_predict_labels(img_path)
    return ((prediction <= 268) & (prediction >= 151))
```

(IMPLEMENTATION) Assess the Dog Detector

Question 3: Use the code cell below to test the performance of your `dog_detector` function.

- What percentage of the images in `human_files_short` have a detected dog?

- What percentage of the images in `dog_files_short` have a detected dog?

Answer:

- much better result in both cases (humans , dogs)
- In my case misclassified as human are 1%, good result
- 100% are dogs in the dogs list, perfect result

```
### TODO: Test the performance of the dog_detector function
### on the images in human_files_short and dog_files_short.

# func get percentage of dogs in the human list
def getPercentageOfDogAsHuman():
    count = 0
    for img in human_files_short:
        if dog_detector(img):
            count += 1
    return getPercentage(count, getLength(human_files_short))

# func get percentage of dogs in the dog list
def getPercentageOfDog():
    count = 0
    for img in dog_files_short:
        if dog_detector(img):
            count += 1
    return getPercentage(count, getLength(dog_files_short))

print('Results are:')
print('{}% Percentage of dogs misclassified as human'.format(getPercentageOfDogAsHuman()))
print('{}% Percentage of dogs correctly classified '.format(getPercentageOfDog()))
```

```
Results are:
1.0% Percentage of dogs misclassified as human
100.0% Percentage of dogs correctly classified
```

Step 3: Create a CNN to Classify Dog Breeds (from Scratch)

Now that we have functions for detecting humans and dogs in images, we need a way to predict breed from images. In this step, you will create a CNN that classifies dog breeds. You must create your CNN *from scratch* (so, you can't use transfer learning yet!), and you must attain a test accuracy of at least 1%. In Step 5 of this notebook, you will have the opportunity to use transfer learning to create a CNN that attains greatly improved accuracy.

Be careful with adding too many trainable layers! More parameters means longer training, which means you are more likely to need a GPU to accelerate the training process. Thankfully, Keras provides a handy estimate of the time that each epoch is likely to take; you can extrapolate this estimate to figure out how long it will take for your algorithm to train.

We mention that the task of assigning breed to dogs from images is considered exceptionally challenging. To see why, consider that *even a human* would have great difficulty in distinguishing between a Brittany and a Welsh Springer Spaniel.

Brittany	Welsh Springer Spaniel

It is not difficult to find other dog breed pairs with minimal inter-class variation (for instance, Curly-Coated Retrievers and American Water Spaniels).

Curly-Coated Retriever	American Water Spaniel
------------------------	------------------------

Likewise, recall that labradors come in yellow, chocolate, and black. Your vision-based algorithm will have to conquer this high intra-class variation to determine how to classify all of these different shades as the same breed.

Yellow Labrador | Chocolate Labrador | Black Labrador

- | - |

We also mention that random chance presents an exceptionally low bar: setting aside the fact that the classes are slightly imabalanced, a random guess will provide a correct answer roughly 1 in 133 times, which corresponds to an accuracy of less than 1%.

Remember that the practice is far ahead of the theory in deep learning. Experiment with many different architectures, and trust your intuition. And, of course, have fun!

Pre-process the Data

We rescale the images by dividing every pixel in every image by 255.

```
from PIL import ImageFile
ImageFile.LOAD_TRUNCATED_IMAGES = True

# pre-process the data for Keras
train_tensors = paths_to_tensor(train_files).astype('float32')/255
valid_tensors = paths_to_tensor(valid_files).astype('float32')/255
test_tensors = paths_to_tensor(test_files).astype('float32')/255
```



(IMPLEMENTATION) Model Architecture

Create a CNN to classify dog breed. At the end of your code cell block, summarize the layers of your model by executing the line:

```
model.summary()
```

We have imported some Python modules to get you started, but feel free to import as many modules as you need. If you end up getting stuck, here's a hint that specifies a model that trains relatively fast on CPU and attains > 1% test

accuracy in 5 epochs:

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 223, 223, 16)	208
max_pooling2d_1 (MaxPooling2D)	(None, 111, 111, 16)	0
conv2d_2 (Conv2D)	(None, 110, 110, 32)	2080
max_pooling2d_2 (MaxPooling2D)	(None, 55, 55, 32)	0
conv2d_3 (Conv2D)	(None, 54, 54, 64)	8256
max_pooling2d_3 (MaxPooling2D)	(None, 27, 27, 64)	0
global_average_pooling2d_1 (GlobalAveragePooling2D)	(None, 64)	0
dense_1 (Dense)	(None, 133)	8645
Total params: 19,189.0		
Trainable params: 19,189.0		
Non-trainable params: 0.0		

INPUT

CONV

POOL

CONV

POOL

CONV

POOL

GAP

DENSE

Question 4: Outline the steps you took to get to your final CNN architecture and your reasoning at each step. If you chose to use the hinted architecture above, describe why you think that CNN architecture should work well for the image classification task.

Answer:

- I am using your CNN architecture model (your image) with GlobalAverage with "channels_last" as parameter
- My starting point was the version from the previous chapter (standard basic CNN structure for image recognitio)
- Dropout's to prevent overfitting
- In the traning proces I will try image augmentation, to get better result
- 224, 244 input shape with 3 color channels (based on path_to_tensor with the target_size 244, 244)
- I will try 5 epochs (based on the recommendation)

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

model = Sequential()

### TODO: Define your architecture.
model.add(Conv2D(filters=16, kernel_size=2, padding='same', activation='relu', input_shape=(224, 224, 3)))
model.add(MaxPooling2D(pool_size=2))
model.add(Conv2D(filters=32, kernel_size=2, padding='same', activation='relu'))
model.add(MaxPooling2D(pool_size=2))
model.add(Conv2D(filters=64, kernel_size=2, padding='same', activation='relu'))
model.add(MaxPooling2D(pool_size=2))
model.add(Dropout(0.2))
model.add(GlobalAveragePooling2D(data_format='channels_last'))
model.add(Dropout(0.3))
model.add(Dense(133, activation='softmax'))

model.summary()
```

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 224, 224, 16)	208
max_pooling2d_2 (MaxPooling2D)	(None, 112, 112, 16)	0
conv2d_2 (Conv2D)	(None, 112, 112, 32)	2080
max_pooling2d_3 (MaxPooling2D)	(None, 56, 56, 32)	0
conv2d_3 (Conv2D)	(None, 56, 56, 64)	8256
max_pooling2d_4 (MaxPooling2D)	(None, 28, 28, 64)	0
dropout_1 (Dropout)	(None, 28, 28, 64)	0
global_average_pooling2d_1 (GlobalAveragePooling2D)	(None, 64)	0
dropout_2 (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 133)	8645
Total params: 19,189		
Trainable params: 19,189		
Non-trainable params: 0		

Compile the Model

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

(IMPLEMENTATION) Train the Model

Train your model in the code cell below. Use model checkpointing to save the model that attains the best validation loss.

You are welcome to [augment the training data](#), but this is not a requirement.

```
from keras.preprocessing.image import ImageDataGenerator

# setup for image augmentation, with random 10% width and height and flip is aktiv
datagen = ImageDataGenerator(
    width_shift_range=0.1,
    height_shift_range=0.1,
    horizontal_flip=True)
```

```
# fit on train_tensors data
datagen.fit(train_tensors)

from keras.callbacks import ModelCheckpoint

### TODO: specify the number of epochs that you would like to use to train the model.

epochs = 5

### Do NOT modify the code below this line.

checkpointer = ModelCheckpoint(filepath='saved_models/weights.best.from_scratch.hdf5',verbose=1, save_best_only=True)

# original: model.fit(train_tensors, train_targets, validation_data=(valid_tensors, valid_targets),epochs=epochs, batch_size=20, callbacks=[checkpointer], verbose=1)
### Using Image Augmentation
batch_size = 20
model.fit_generator(datagen.flow(train_tensors, train_targets, batch_size = batch_size),
                    steps_per_epoch = train_tensors.shape[0] // batch_size,
                    epochs = epochs, verbose = 1, callbacks = [checkpointer],
                    validation_data = (valid_tensors, valid_targets))
```

```
Epoch 1/5
205/334 [=====>.....] - ETA: 468s - loss: 4.8695 - acc: 0.0000e+0 - ETA: 332s - loss: 4.8737 - acc: 0.0250 - ETA: 290s - loss: 4.8747 - acc: 0.016 - ETA:
268s - loss: 4.8825 - acc: 0.012 - ETA: 254s - loss: 4.8826 - acc: 0.010 - ETA: 245s - loss: 4.8933 - acc: 0.008 - ETA: 238s - loss: 4.8945 - acc: 0.007 - ETA: 232s - loss:
4.8942 - acc: 0.006 - ETA: 229s - loss: 4.8925 - acc: 0.005 - ETA: 229s - loss: 4.8924 - acc: 0.005 - ETA: 228s - loss: 4.8903 - acc: 0.004 - ETA: 225s - loss: 4.8890 - acc:
0.004 - ETA: 223s - loss: 4.8896 - acc: 0.003 - ETA: 222s - loss: 4.8895 - acc: 0.003 - ETA: 221s - loss: 4.8930 - acc: 0.003 - ETA: 220s - loss: 4.8914 - acc: 0.003 - ETA: 218s
- loss: 4.8895 - acc: 0.002 - ETA: 217s - loss: 4.8883 - acc: 0.005 - ETA: 216s - loss: 4.8899 - acc: 0.005 - ETA: 214s - loss: 4.8901 - acc: 0.007 - ETA: 213s - loss: 4.8913 -
acc: 0.007 - ETA: 212s - loss: 4.8914 - acc: 0.006 - ETA: 211s - loss: 4.8910 - acc: 0.006 - ETA: 211s - loss: 4.8918 - acc: 0.006 - ETA: 210s - loss: 4.8924 - acc: 0.006 - ETA:
209s - loss: 4.8938 - acc: 0.005 - ETA: 208s - loss: 4.8946 - acc: 0.005 - ETA: 207s - loss: 4.8955 - acc: 0.005 - ETA: 206s - loss: 4.8957 - acc: 0.006 - ETA: 205s - loss:
4.8959 - acc: 0.006 - ETA: 203s - loss: 4.8968 - acc: 0.006 - ETA: 202s - loss: 4.8969 - acc: 0.006 - ETA: 201s - loss: 4.8968 - acc: 0.006 - ETA: 200s - loss: 4.8961 - acc:
0.005 - ETA: 199s - loss: 4.8959 - acc: 0.007 - ETA: 199s - loss: 4.8963 - acc: 0.006 - ETA: 198s - loss: 4.8965 - acc: 0.006 - ETA: 197s - loss: 4.8963 - acc: 0.007 - ETA: 196s
- loss: 4.8959 - acc: 0.007 - ETA: 195s - loss: 4.8954 - acc: 0.007 - ETA: 195s - loss: 4.8955 - acc: 0.007 - ETA: 194s - loss: 4.8965 - acc: 0.007 - ETA: 193s - loss: 4.8959 -
acc: 0.007 - ETA: 193s - loss: 4.8952 - acc: 0.006 - ETA: 192s - loss: 4.8950 - acc: 0.007 - ETA: 191s - loss: 4.8946 - acc: 0.007 - ETA: 190s - loss: 4.8940 - acc: 0.008 - ETA:
190s - loss: 4.8941 - acc: 0.009 - ETA: 189s - loss: 4.8939 - acc: 0.009 - ETA: 188s - loss: 4.8946 - acc: 0.009 - ETA: 187s - loss: 4.8945 - acc: 0.008 - ETA: 186s - loss:
4.8940 - acc: 0.008 - ETA: 185s - loss: 4.8944 - acc: 0.008 - ETA: 185s - loss: 4.8942 - acc: 0.008 - ETA: 184s - loss: 4.8943 - acc: 0.008 - ETA: 183s - loss: 4.8942 - acc:
0.008 - ETA: 182s - loss: 4.8938 - acc: 0.007 - ETA: 181s - loss: 4.8940 - acc: 0.008 - ETA: 180s - loss: 4.8944 - acc: 0.008 - ETA: 180s - loss: 4.8944 - acc: 0.008 - ETA: 179s
- loss: 4.8940 - acc: 0.008 - ETA: 178s - loss: 4.8942 - acc: 0.008 - ETA: 177s - loss: 4.8942 - acc: 0.007 - ETA: 176s - loss: 4.8940 - acc: 0.008 - ETA: 176s - loss: 4.8940 -
acc: 0.008 - ETA: 175s - loss: 4.8936 - acc: 0.008 - ETA: 174s - loss: 4.8933 - acc: 0.008 - ETA: 173s - loss: 4.8930 - acc: 0.008 - ETA: 173s - loss: 4.8930 - acc: 0.008 - ETA:
172s - loss: 4.8929 - acc: 0.007 - ETA: 171s - loss: 4.8929 - acc: 0.008 - ETA: 171s - loss: 4.8929 - acc: 0.008 - ETA: 170s - loss: 4.8927 - acc: 0.008 - ETA: 169s - loss:
4.8926 - acc: 0.008 - ETA: 169s - loss: 4.8924 - acc: 0.008 - ETA: 168s - loss: 4.8922 - acc: 0.008 - ETA: 167s - loss: 4.8916 - acc: 0.008 - ETA: 166s - loss: 4.8913 - acc:
0.009 - ETA: 166s - loss: 4.8915 - acc: 0.009 - ETA: 165s - loss: 4.8914 - acc: 0.010 - ETA: 164s - loss: 4.8916 - acc: 0.009 - ETA: 164s - loss: 4.8912 - acc: 0.009 - ETA: 163s
- loss: 4.8909 - acc: 0.009 - ETA: 162s - loss: 4.8909 - acc: 0.010 - ETA: 161s - loss: 4.8912 - acc: 0.010 - ETA: 161s - loss: 4.8914 - acc: 0.009 - ETA: 160s - loss: 4.8913 -
acc: 0.009 - ETA: 159s - loss: 4.8914 - acc: 0.009 - ETA: 159s - loss: 4.8914 - acc: 0.010 - ETA: 158s - loss: 4.8918 - acc: 0.010 - ETA: 157s - loss: 4.8915 - acc: 0.009 - ETA:
157s - loss: 4.8915 - acc: 0.009 - ETA: 156s - loss: 4.8914 - acc: 0.009 - ETA: 155s - loss: 4.8913 - acc: 0.009 - ETA: 155s - loss: 4.8914 - acc: 0.009 - ETA: 154s - loss:
4.8915 - acc: 0.009 - ETA: 153s - loss: 4.8918 - acc: 0.009 - ETA: 153s - loss: 4.8916 - acc: 0.010 - ETA: 152s - loss: 4.8916 - acc: 0.010 - ETA: 151s - loss: 4.8914 - acc:
0.010 - ETA: 151s - loss: 4.8913 - acc: 0.009 - ETA: 150s - loss: 4.8912 - acc: 0.009 - ETA: 149s - loss: 4.8909 - acc: 0.010 - ETA: 149s - loss: 4.8911 - acc: 0.010 - ETA: 148s
- loss: 4.8914 - acc: 0.010 - ETA: 147s - loss: 4.8916 - acc: 0.009 - ETA: 147s - loss: 4.8915 - acc: 0.009 - ETA: 146s - loss: 4.8915 - acc: 0.009 - ETA: 145s - loss: 4.8915 -
acc: 0.009 - ETA: 144s - loss: 4.8916 - acc: 0.009 - ETA: 144s - loss: 4.8915 - acc: 0.009 - ETA: 143s - loss: 4.8912 - acc: 0.009 - ETA: 142s - loss: 4.8912 - acc: 0.009 - ETA:
```


[illegible]


```
loss: 4.8707 - acc: 0.01 - ETA: 62s - loss: 4.8708 - acc: 0.01 - ETA: 61s - loss: 4.8708 - acc: 0.01 - ETA: 60s - loss: 4.8707 - acc: 0.01 - ETA: 60s - loss: 4.8705 - acc: 0.01 -
ETA: 59s - loss: 4.8706 - acc: 0.01 - ETA: 59s - loss: 4.8705 - acc: 0.01 - ETA: 58s - loss: 4.8704 - acc: 0.01 - ETA: 57s - loss: 4.8707 - acc: 0.01 - ETA: 57s - loss: 4.8706 -
acc: 0.01 - ETA: 56s - loss: 4.8709 - acc: 0.01 - ETA: 55s - loss: 4.8710 - acc: 0.01 - ETA: 55s - loss: 4.8709 - acc: 0.01 - ETA: 54s - loss: 4.8709 - acc: 0.01 - ETA: 54s -
loss: 4.8708 - acc: 0.01 - ETA: 53s - loss: 4.8707 - acc: 0.01 - ETA: 52s - loss: 4.8707 - acc: 0.01 - ETA: 52s - loss: 4.8707 - acc: 0.01 - ETA: 51s - loss: 4.8706 - acc: 0.01 -
ETA: 50s - loss: 4.8705 - acc: 0.01 - ETA: 50s - loss: 4.8705 - acc: 0.01 - ETA: 49s - loss: 4.8704 - acc: 0.01 - ETA: 48s - loss: 4.8706 - acc: 0.01 - ETA: 48s - loss: 4.8705 -
acc: 0.01 - ETA: 47s - loss: 4.8703 - acc: 0.01 - ETA: 47s - loss: 4.8702 - acc: 0.01 - ETA: 46s - loss: 4.8704 - acc: 0.01 - ETA: 45s - loss: 4.8703 - acc: 0.01 - ETA: 45s -
loss: 4.8704 - acc: 0.01 - ETA: 44s - loss: 4.8706 - acc: 0.01 - ETA: 43s - loss: 4.8707 - acc: 0.01 - ETA: 43s - loss: 4.8708 - acc: 0.01 - ETA: 42s - loss: 4.8709 - acc: 0.01 -
ETA: 42s - loss: 4.8708 - acc: 0.01 - ETA: 41s - loss: 4.8709 - acc: 0.01 - ETA: 40s - loss: 4.8709 - acc: 0.01 - ETA: 40s - loss: 4.8708 - acc: 0.01 - ETA: 39s - loss: 4.8708 -
acc: 0.01 - ETA: 38s - loss: 4.8708 - acc: 0.01 - ETA: 38s - loss: 4.8710 - acc: 0.01 - ETA: 37s - loss: 4.8710 - acc: 0.01 - ETA: 36s - loss: 4.8708 - acc: 0.01 - ETA: 36s -
loss: 4.8710 - acc: 0.01 - ETA: 35s - loss: 4.8712 - acc: 0.01 - ETA: 35s - loss: 4.8711 - acc: 0.01 - ETA: 34s - loss: 4.8711 - acc: 0.01 - ETA: 33s - loss: 4.8713 - acc: 0.01 -
ETA: 33s - loss: 4.8713 - acc: 0.01 - ETA: 32s - loss: 4.8715 - acc: 0.01 - ETA: 31s - loss: 4.8714 - acc: 0.01 - ETA: 31s - loss: 4.8715 - acc: 0.01 - ETA: 30s - loss: 4.8713 -
acc: 0.01 - ETA: 29s - loss: 4.8714 - acc: 0.01 - ETA: 29s - loss: 4.8716 - acc: 0.01 - ETA: 28s - loss: 4.8715 - acc: 0.01 - ETA: 28s - loss: 4.8713 - acc: 0.01 - ETA: 27s -
loss: 4.8710 - acc: 0.01 - ETA: 26s - loss: 4.8708 - acc: 0.01 - ETA: 26s - loss: 4.8708 - acc: 0.01 - ETA: 25s - loss: 4.8712 - acc: 0.01 - ETA: 24s - loss: 4.8714 - acc: 0.01 -
ETA: 24s - loss: 4.8715 - acc: 0.01 - ETA: 23s - loss: 4.8716 - acc: 0.01 - ETA: 22s - loss: 4.8716 - acc: 0.01 - ETA: 22s - loss: 4.8718 - acc: 0.01 - ETA: 21s - loss: 4.8717 -
acc: 0.01 - ETA: 21s - loss: 4.8717 - acc: 0.01 - ETA: 20s - loss: 4.8715 - acc: 0.01 - ETA: 19s - loss: 4.8717 - acc: 0.01 - ETA: 19s - loss: 4.8717 - acc: 0.01 - ETA: 18s -
loss: 4.8716 - acc: 0.01 - ETA: 17s - loss: 4.8715 - acc: 0.01 - ETA: 17s - loss: 4.8714 - acc: 0.01 - ETA: 16s - loss: 4.8714 - acc: 0.01 - ETA: 15s - loss: 4.8714 - acc: 0.01 -
ETA: 15s - loss: 4.8715 - acc: 0.01 - ETA: 14s - loss: 4.8714 - acc: 0.01 - ETA: 14s - loss: 4.8714 - acc: 0.01 - ETA: 13s - loss: 4.8715 - acc: 0.01 - ETA: 12s - loss: 4.8715 -
acc: 0.01 - ETA: 12s - loss: 4.8713 - acc: 0.01 - ETA: 11s - loss: 4.8713 - acc: 0.01 - ETA: 10s - loss: 4.8714 - acc: 0.01 - ETA: 10s - loss: 4.8713 - acc: 0.01 - ETA: 9s -
loss: 4.8712 - acc: 0.0116 - ETA: 8s - loss: 4.8714 - acc: 0.011 - ETA: 8s - loss: 4.8714 - acc: 0.011 - ETA: 7s - loss: 4.8714 - acc: 0.011 - ETA: 7s - loss: 4.8713 - acc: 0.011
- ETA: 6s - loss: 4.8713 - acc: 0.011 - ETA: 5s - loss: 4.8714 - acc: 0.011 - ETA: 5s - loss: 4.8717 - acc: 0.011 - ETA: 4s - loss: 4.8715 - acc: 0.011 - ETA: 3s - loss: 4.8712 -
acc: 0.011 - ETA: 3s - loss: 4.8710 - acc: 0.011 - ETA: 2s - loss: 4.8711 - acc: 0.011 - ETA: 1s - loss: 4.8709 - acc: 0.011 - ETA: 1s - loss: 4.8706 - acc: 0.011 - ETA: 0s -
loss: 4.8705 - acc: 0.0117Epoch 00001: val_loss improved from 4.86903 to 4.86095, saving model to saved_models/weights.best.from_scratch.hdf5
334/334 [=====] - 221s - loss: 4.8709 - acc: 0.0117 - val_loss: 4.8609 - val_acc: 0.0120
Epoch 3/5
206/334 [=====>.....] - ETA: 211s - loss: 4.9582 - acc: 0.0000e+0 - ETA: 209s - loss: 4.8852 - acc: 0.0250 - ETA: 209s - loss: 4.9052 - acc: 0.016 - ETA:
209s - loss: 4.8904 - acc: 0.012 - ETA: 207s - loss: 4.8831 - acc: 0.020 - ETA: 208s - loss: 4.8756 - acc: 0.016 - ETA: 207s - loss: 4.8705 - acc: 0.021 - ETA: 206s - loss:
4.8768 - acc: 0.018 - ETA: 205s - loss: 4.8760 - acc: 0.016 - ETA: 204s - loss: 4.8683 - acc: 0.020 - ETA: 204s - loss: 4.8646 - acc: 0.018 - ETA: 204s - loss: 4.8649 - acc:
0.020 - ETA: 203s - loss: 4.8712 - acc: 0.019 - ETA: 202s - loss: 4.8696 - acc: 0.017 - ETA: 201s - loss: 4.8714 - acc: 0.016 - ETA: 201s - loss: 4.8744 - acc: 0.015 - ETA: 200s
- loss: 4.8713 - acc: 0.017 - ETA: 199s - loss: 4.8691 - acc: 0.016 - ETA: 199s - loss: 4.8670 - acc: 0.015 - ETA: 199s - loss: 4.8632 - acc: 0.017 - ETA: 198s - loss: 4.8615 -
acc: 0.016 - ETA: 197s - loss: 4.8634 - acc: 0.015 - ETA: 196s - loss: 4.8627 - acc: 0.015 - ETA: 196s - loss: 4.8652 - acc: 0.014 - ETA: 195s - loss: 4.8631 - acc: 0.014 - ETA:
194s - loss: 4.8611 - acc: 0.015 - ETA: 193s - loss: 4.8587 - acc: 0.014 - ETA: 192s - loss: 4.8565 - acc: 0.016 - ETA: 192s - loss: 4.8550 - acc: 0.015 - ETA: 191s - loss:
4.8537 - acc: 0.015 - ETA: 190s - loss: 4.8520 - acc: 0.016 - ETA: 189s - loss: 4.8524 - acc: 0.018 - ETA: 189s - loss: 4.8503 - acc: 0.018 - ETA: 188s - loss: 4.8517 - acc:
0.019 - ETA: 188s - loss: 4.8517 - acc: 0.018 - ETA: 187s - loss: 4.8528 - acc: 0.018 - ETA: 186s - loss: 4.8533 - acc: 0.017 - ETA: 186s - loss: 4.8523 - acc: 0.017 - ETA: 185s
- loss: 4.8516 - acc: 0.016 - ETA: 184s - loss: 4.8518 - acc: 0.016 - ETA: 184s - loss: 4.8516 - acc: 0.015 - ETA: 183s - loss: 4.8520 - acc: 0.015 - ETA: 182s - loss: 4.8523 -
acc: 0.015 - ETA: 182s - loss: 4.8519 - acc: 0.014 - ETA: 181s - loss: 4.8514 - acc: 0.014 - ETA: 180s - loss: 4.8531 - acc: 0.016 - ETA: 180s - loss: 4.8535 - acc: 0.018 - ETA:
179s - loss: 4.8539 - acc: 0.017 - ETA: 178s - loss: 4.8566 - acc: 0.017 - ETA: 178s - loss: 4.8579 - acc: 0.017 - ETA: 177s - loss: 4.8575 - acc: 0.017 - ETA: 177s - loss:
4.8569 - acc: 0.019 - ETA: 176s - loss: 4.8554 - acc: 0.018 - ETA: 175s - loss: 4.8559 - acc: 0.018 - ETA: 175s - loss: 4
```


[illegible]

```
acc: 0.01 - ETA: 56s - loss: 4.8287 - acc: 0.01 - ETA: 55s - loss: 4.8281 - acc: 0.01 - ETA: 54s - loss: 4.8281 - acc: 0.01 - ETA: 54s - loss: 4.8281 - acc: 0.01 - ETA: 53s -
loss: 4.8277 - acc: 0.01 - ETA: 52s - loss: 4.8282 - acc: 0.01 - ETA: 52s - loss: 4.8282 - acc: 0.01 - ETA: 51s - loss: 4.8283 - acc: 0.01 - ETA: 50s - loss: 4.8285 - acc: 0.01 -
ETA: 50s - loss: 4.8286 - acc: 0.01 - ETA: 49s - loss: 4.8292 - acc: 0.01 - ETA: 49s - loss: 4.8292 - acc: 0.01 - ETA: 48s - loss: 4.8293 - acc: 0.01 - ETA: 47s - loss: 4.8289 -
acc: 0.01 - ETA: 47s - loss: 4.8293 - acc: 0.01 - ETA: 46s - loss: 4.8290 - acc: 0.01 - ETA: 45s - loss: 4.8288 - acc: 0.01 - ETA: 45s - loss: 4.8287 - acc: 0.01 - ETA: 44s -
loss: 4.8286 - acc: 0.01 - ETA: 44s - loss: 4.8287 - acc: 0.01 - ETA: 43s - loss: 4.8293 - acc: 0.01 - ETA: 42s - loss: 4.8289 - acc: 0.01 - ETA: 42s - loss: 4.8291 - acc: 0.01 -
ETA: 41s - loss: 4.8293 - acc: 0.01 - ETA: 40s - loss: 4.8296 - acc: 0.01 - ETA: 40s - loss: 4.8297 - acc: 0.01 - ETA: 39s - loss: 4.8296 - acc: 0.01 - ETA: 38s - loss: 4.8297 -
acc: 0.01 - ETA: 38s - loss: 4.8297 - acc: 0.01 - ETA: 37s - loss: 4.8302 - acc: 0.01 - ETA: 37s - loss: 4.8303 - acc: 0.01 - ETA: 36s - loss: 4.8304 - acc: 0.01 - ETA: 35s -
loss: 4.8304 - acc: 0.01 - ETA: 35s - loss: 4.8305 - acc: 0.01 - ETA: 34s - loss: 4.8301 - acc: 0.01 - ETA: 33s - loss: 4.8302 - acc: 0.01 - ETA: 33s - loss: 4.8301 - acc: 0.01 -
ETA: 32s - loss: 4.8303 - acc: 0.01 - ETA: 32s - loss: 4.8302 - acc: 0.01 - ETA: 31s - loss: 4.8301 - acc: 0.01 - ETA: 30s - loss: 4.8298 - acc: 0.01 - ETA: 30s - loss: 4.8297 -
acc: 0.01 - ETA: 29s - loss: 4.8300 - acc: 0.01 - ETA: 28s - loss: 4.8298 - acc: 0.01 - ETA: 28s - loss: 4.8295 - acc: 0.01 - ETA: 27s - loss: 4.8294 - acc: 0.01 - ETA: 27s -
loss: 4.8296 - acc: 0.01 - ETA: 26s - loss: 4.8302 - acc: 0.01 - ETA: 25s - loss: 4.8302 - acc: 0.01 - ETA: 25s - loss: 4.8299 - acc: 0.01 - ETA: 24s - loss: 4.8301 - acc: 0.01 -
ETA: 23s - loss: 4.8302 - acc: 0.01 - ETA: 23s - loss: 4.8301 - acc: 0.01 - ETA: 22s - loss: 4.8300 - acc: 0.01 - ETA: 22s - loss: 4.8298 - acc: 0.01 - ETA: 21s - loss: 4.8299 -
acc: 0.01 - ETA: 20s - loss: 4.8302 - acc: 0.01 - ETA: 20s - loss: 4.8305 - acc: 0.01 - ETA: 19s - loss: 4.8306 - acc: 0.01 - ETA: 18s - loss: 4.8309 - acc: 0.01 - ETA: 18s -
loss: 4.8307 - acc: 0.01 - ETA: 17s - loss: 4.8306 - acc: 0.01 - ETA: 16s - loss: 4.8303 - acc: 0.01 - ETA: 16s - loss: 4.8307 - acc: 0.01 - ETA: 15s - loss: 4.8305 - acc: 0.01 -
ETA: 15s - loss: 4.8308 - acc: 0.01 - ETA: 14s - loss: 4.8310 - acc: 0.01 - ETA: 13s - loss: 4.8311 - acc: 0.01 - ETA: 13s - loss: 4.8307 - acc: 0.01 - ETA: 12s - loss: 4.8304 -
acc: 0.01 - ETA: 11s - loss: 4.8301 - acc: 0.01 - ETA: 11s - loss: 4.8300 - acc: 0.01 - ETA: 10s - loss: 4.8301 - acc: 0.01 - ETA: 10s - loss: 4.8308 - acc: 0.01 - ETA: 9s -
loss: 4.8307 - acc: 0.0166 - ETA: 8s - loss: 4.8305 - acc: 0.016 - ETA: 8s - loss: 4.8306 - acc: 0.016 - ETA: 7s - loss: 4.8309 - acc: 0.016 - ETA: 6s - loss: 4.8308 - acc: 0.016
- ETA: 6s - loss: 4.8308 - acc: 0.016 - ETA: 5s - loss: 4.8307 - acc: 0.016 - ETA: 5s - loss: 4.8307 - acc: 0.016 - ETA: 4s - loss: 4.8312 - acc: 0.016 - ETA: 3s - loss: 4.8314 -
acc: 0.016 - ETA: 3s - loss: 4.8311 - acc: 0.016 - ETA: 2s - loss: 4.8312 - acc: 0.016 - ETA: 1s - loss: 4.8309 - acc: 0.016 - ETA: 1s - loss: 4.8305 - acc: 0.016 - ETA: 0s -
loss: 4.8306 - acc: 0.0167Epoch 00003: val_loss improved from 4.84224 to 4.81764, saving model to saved_models/weights.best.from_scratch.hdf5
334/334 [=====] - 218s - loss: 4.8303 - acc: 0.0166 - val_loss: 4.8176 - val_acc: 0.0204
Epoch 5/5
205/334 [=====>.....] - ETA: 204s - loss: 4.8311 - acc: 0.0000e+0 - ETA: 202s - loss: 4.7669 - acc: 0.0000e+0 - ETA: 204s - loss: 4.7011 - acc: 0.0167 -
ETA: 203s - loss: 4.7152 - acc: 0.012 - ETA: 203s - loss: 4.7552 - acc: 0.010 - ETA: 202s - loss: 4.7468 - acc: 0.016 - ETA: 202s - loss: 4.7522 - acc: 0.014 - ETA: 202s - loss:
4.7588 - acc: 0.012 - ETA: 202s - loss: 4.7640 - acc: 0.011 - ETA: 201s - loss: 4.7750 - acc: 0.015 - ETA: 200s - loss: 4.7715 - acc: 0.018 - ETA: 199s - loss: 4.7683 - acc:
0.020 - ETA: 199s - loss: 4.7761 - acc: 0.019 - ETA: 199s - loss: 4.7685 - acc: 0.017 - ETA: 198s - loss: 4.7724 - acc: 0.016 - ETA: 197s - loss: 4.7807 - acc: 0.018 - ETA: 197s
- loss: 4.7891 - acc: 0.017 - ETA: 196s - loss: 4.7932 - acc: 0.016 - ETA: 195s - loss: 4.7967 - acc: 0.015 - ETA: 195s - loss: 4.7950 - acc: 0.015 - ETA: 194s - loss: 4.7980 -
acc: 0.014 - ETA: 193s - loss: 4.7926 - acc: 0.013 - ETA: 193s - loss: 4.7876 - acc: 0.013 - ETA: 192s - loss: 4.7845 - acc: 0.012 - ETA: 192s - loss: 4.7903 - acc: 0.012 - ETA:
191s - loss: 4.7893 - acc: 0.013 - ETA: 190s - loss: 4.7903 - acc: 0.014 - ETA: 190s - loss: 4.7909 - acc: 0.014 - ETA: 189s - loss: 4.7942 - acc: 0.015 - ETA: 189s - loss:
4.7973 - acc: 0.015 - ETA: 188s - loss: 4.7928 - acc: 0.014 - ETA: 187s - loss: 4.7900 - acc: 0.017 - ETA: 186s - loss: 4.7892 - acc: 0.016 - ETA: 186s - loss: 4.7904 - acc:
0.017 - ETA: 185s - loss: 4.7889 - acc: 0.017 - ETA: 185s - loss: 4.7868 - acc: 0.018 - ETA: 184s - loss: 4.7849 - acc: 0.017 - ETA: 183s - loss: 4.7843 - acc: 0.017 - ETA: 183s
- loss: 4.7855 - acc: 0.017 - ETA: 182s - loss: 4.7851 - acc: 0.017 - ETA: 181s - loss: 4.7855 - acc: 0.018 - ETA: 181s - loss: 4.7859 - acc: 0.017 - ETA: 180s - loss: 4.7904 -
acc: 0.017 - ETA: 179s - loss: 4.7902 - acc: 0.017 - ETA: 179s - loss: 4.7923 - acc: 0.016 - ETA: 178s - loss: 4.7896 - acc: 0.018 - ETA: 178s - loss: 4.7897 - acc: 0.021 - ETA:
177s - loss: 4.7867 - acc: 0.022 - ETA: 176s - loss: 4.7810 - acc: 0.025 - ETA: 176s - loss: 4.7830 - acc: 0.025 - ETA: 175s - loss: 4.7807 - acc: 0.024 - ETA: 174s - loss:
4.7825 - acc: 0.024 - ETA: 174s - loss: 4.7826 - acc: 0.023 - ETA: 173s - loss: 4.7820 - acc: 0.023 - ETA: 173s - loss: 4.7824 - acc: 0.022 - ETA: 172s - loss: 4.7843 - acc:
0.022 - ETA: 171s - loss: 4.7830 - acc: 0.022 - ETA: 171s - loss: 4.7852 - acc: 0.023 - ETA: 170s - loss: 4.7841 - acc: 0.024 - ETA: 170s - loss: 4.7860 - acc: 0.024 - ETA: 169s
- loss: 4.7846 - acc: 0.024 - ETA: 168s - loss: 4.7867 - acc: 0.024 - ETA: 168s - loss: 4.7845 - acc: 0.024 -
```

```
<keras.callbacks.History at 0x2013b65df28>
```

Load the Model with the Best Validation Loss

```
model.load_weights('saved_models/weights.best.from_scratch.hdf5')
```

Test the Model

Try out your model on the test dataset of dog images. Ensure that your test accuracy is greater than 1%.

```
# get index of predicted dog breed for each image in test set
dog_breed_predictions = [np.argmax(model.predict(np.expand_dims(tensor, axis=0))) for tensor in test_tensors]

# report test accuracy
test_accuracy = 100*np.sum(np.array(dog_breed_predictions)==np.argmax(test_targets, axis=1))/len(dog_breed_predictions)
print('Test accuracy: %.4f%%' % test_accuracy)
```

Test accuracy: 2.3923%

Step 4: Use a CNN to Classify Dog Breeds

To reduce training time without sacrificing accuracy, we show you how to train a CNN using transfer learning. In the following step, you will get a chance to use transfer learning to train your own CNN.

Obtain Bottleneck Features

```
bottleneck_features = np.load('bottleneck_features/DogVGG16Data.npz')
train_VGG16 = bottleneck_features['train']
valid_VGG16 = bottleneck_features['valid']
test_VGG16 = bottleneck_features['test']
```

Model Architecture

The model uses the the pre-trained VGG-16 model as a fixed feature extractor, where the last convolutional output of VGG-16 is fed as input to our model. We only add a global average pooling layer and a fully connected layer, where the latter contains one node for each dog category and is equipped with a softmax.

```
VGG16_model = Sequential()
VGG16_model.add(GlobalAveragePooling2D(input_shape=train_VGG16.shape[1:]))
VGG16_model.add(Dense(133, activation='softmax'))

VGG16_model.summary()
```

Layer (type)	Output Shape	Param #
global_average_pooling2d_4 ((None, 512)		0
dense_4 (Dense)	(None, 133)	68229
Total params: 68,229		
Trainable params: 68,229		
Non-trainable params: 0		

Compile the Model

```
VGG16_model.compile(loss='categorical_crossentropy', optimizer='rmsprop', metrics=['accuracy'])
```

Train the Model

```
checkpointer = ModelCheckpoint(filepath='saved_models/weights.best.VGG16.hdf5',
                               verbose=1, save_best_only=True)

VGG16_model.fit(train_VGG16, train_targets,
                validation_data=(valid_VGG16, valid_targets),
                epochs=20, batch_size=20, callbacks=[checkpointer], verbose=1)
```

Train on 6680 samples, validate on 835 samples

Epoch 1/20

```
6640/6680 [=====>.] - ETA: 124s - loss: 15.4760 - acc: 0.0000e+00 - ETA: 15s - loss: 15.4104 - acc: 0.0000e+00 - ETA: 8s - loss: 15.1670 - acc: 0.0118 -
ETA: 6s - loss: 15.0057 - acc: 0.01 - ETA: 5s - loss: 14.8631 - acc: 0.01 - ETA: 4s - loss: 14.6063 - acc: 0.02 - ETA: 4s - loss: 14.3928 - acc: 0.02 - ETA: 3s - loss: 14.3034 -
acc: 0.02 - ETA: 3s - loss: 14.1836 - acc: 0.03 - ETA: 2s - loss: 14.1027 - acc: 0.03 - ETA: 2s - loss: 13.9459 - acc: 0.03 - ETA: 2s - loss: 13.7783 - acc: 0.04 - ETA: 2s -
loss: 13.7066 - acc: 0.05 - ETA: 2s - loss: 13.6828 - acc: 0.04 - ETA: 2s - loss: 13.5781 - acc: 0.05 - ETA: 1s - loss: 13.4827 - acc: 0.05 - ETA: 1s - loss: 13.4494 - acc: 0.05
- ETA: 1s - loss: 13.3784 - acc: 0.06 - ETA: 1s - loss: 13.3304 - acc: 0.06 - ETA: 1s - loss: 13.1938 - acc: 0.06 - ETA: 1s - loss: 13.1315 - acc: 0.06 - ETA: 1s - loss: 13.0370
- acc: 0.07 - ETA: 1s - loss: 12.9727 - acc: 0.07 - ETA: 1s - loss: 12.9012 - acc: 0.07 - ETA: 1s - loss: 12.8713 - acc: 0.08 - ETA: 0s - loss: 12.7638 - acc: 0.08 - ETA: 0s -
loss: 12.6819 - acc: 0.09 - ETA: 0s - loss: 12.6286 - acc: 0.09 - ETA: 0s - loss: 12.5491 - acc: 0.09 - ETA: 0s - loss: 12.4818 - acc: 0.10 - ETA: 0s - loss: 12.4054 - acc: 0.10
- ETA: 0s - loss: 12.3611 - acc: 0.10 - ETA: 0s - loss: 12.2861 - acc: 0.11 - ETA: 0s - loss: 12.2187 - acc: 0.11 - ETA: 0s - loss: 12.1822 - acc: 0.11 - ETA: 0s - loss: 12.1337
- acc: 0.12 - ETA: 0s - loss: 12.0782 - acc: 0.12 - ETA: 0s - loss: 12.0643 - acc: 0.12 - ETA: 0s - loss: 12.0177 - acc: 0.1300Epoch 00000: val_loss improved from inf to
10.31675, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 12.0001 - acc: 0.1307 - val_loss: 10.3167 - val_acc: 0.2275
```

Epoch 2/20

```
6620/6680 [=====>.] - ETA: 2s - loss: 6.9439 - acc: 0.400 - ETA: 2s - loss: 9.6997 - acc: 0.285 - ETA: 1s - loss: 9.9282 - acc: 0.265 - ETA: 1s - loss:
10.1881 - acc: 0.25 - ETA: 1s - loss: 10.0843 - acc: 0.26 - ETA: 1s - loss: 10.2519 - acc: 0.25 - ETA: 1s - loss: 10.2146 - acc: 0.26 - ETA: 1s - loss: 10.2011 - acc: 0.26 - ETA:
1s - loss: 10.0895 - acc: 0.26 - ETA: 1s - loss: 10.0589 - acc: 0.26 - ETA: 1s - loss: 10.0138 - acc: 0.26 - ETA: 1s - loss: 9.9525 - acc: 0.2711 - ETA: 1s - loss: 9.9256 - acc:
```

0.269 - ETA: 1s - loss: 9.9213 - acc: 0.269 - ETA: 1s - loss: 9.9200 - acc: 0.271 - ETA: 1s - loss: 9.9042 - acc: 0.274 - ETA: 1s - loss: 9.9340 - acc: 0.272 - ETA: 1s - loss: 9.8787 - acc: 0.275 - ETA: 1s - loss: 9.8514 - acc: 0.277 - ETA: 0s - loss: 9.7842 - acc: 0.284 - ETA: 0s - loss: 9.7538 - acc: 0.286 - ETA: 0s - loss: 9.7488 - acc: 0.286 - ETA: 0s - loss: 9.7745 - acc: 0.285 - ETA: 0s - loss: 9.7485 - acc: 0.286 - ETA: 0s - loss: 9.7561 - acc: 0.288 - ETA: 0s - loss: 9.7465 - acc: 0.290 - ETA: 0s - loss: 9.7154 - acc: 0.292 - ETA: 0s - loss: 9.6715 - acc: 0.295 - ETA: 0s - loss: 9.6580 - acc: 0.297 - ETA: 0s - loss: 9.6500 - acc: 0.297 - ETA: 0s - loss: 9.6304 - acc: 0.299 - ETA: 0s - loss: 9.6406 - acc: 0.298 - ETA: 0s - loss: 9.6345 - acc: 0.300 - ETA: 0s - loss: 9.6083 - acc: 0.303 - ETA: 0s - loss: 9.5978 - acc: 0.304 - ETA: 0s - loss: 9.5946 - acc: 0.305 - ETA: 0s - loss: 9.5965 - acc: 0.305 - ETA: 0s - loss: 9.5619 - acc: 0.3083Epoch 00001: val_loss improved from 10.31675 to 9.46505, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 9.5597 - acc: 0.3088 - val_loss: 9.4651 - val_acc: 0.3174
Epoch 3/20
6640/6680 [=====>.] - ETA: 2s - loss: 8.5842 - acc: 0.400 - ETA: 1s - loss: 9.0183 - acc: 0.375 - ETA: 1s - loss: 9.0261 - acc: 0.384 - ETA: 1s - loss: 8.9395 - acc: 0.383 - ETA: 1s - loss: 9.1091 - acc: 0.370 - ETA: 1s - loss: 9.1331 - acc: 0.370 - ETA: 1s - loss: 9.1943 - acc: 0.367 - ETA: 1s - loss: 9.2337 - acc: 0.360 - ETA: 1s - loss: 9.1915 - acc: 0.362 - ETA: 1s - loss: 9.2165 - acc: 0.361 - ETA: 1s - loss: 9.2582 - acc: 0.357 - ETA: 1s - loss: 9.2119 - acc: 0.358 - ETA: 1s - loss: 9.2604 - acc: 0.356 - ETA: 1s - loss: 9.2902 - acc: 0.353 - ETA: 1s - loss: 9.3521 - acc: 0.348 - ETA: 1s - loss: 9.3186 - acc: 0.351 - ETA: 1s - loss: 9.2809 - acc: 0.353 - ETA: 1s - loss: 9.2451 - acc: 0.356 - ETA: 1s - loss: 9.2628 - acc: 0.354 - ETA: 1s - loss: 9.2490 - acc: 0.355 - ETA: 0s - loss: 9.2444 - acc: 0.357 - ETA: 0s - loss: 9.2563 - acc: 0.357 - ETA: 0s - loss: 9.2609 - acc: 0.357 - ETA: 0s - loss: 9.1982 - acc: 0.360 - ETA: 0s - loss: 9.1374 - acc: 0.361 - ETA: 0s - loss: 9.1198 - acc: 0.364 - ETA: 0s - loss: 9.1420 - acc: 0.363 - ETA: 0s - loss: 9.1149 - acc: 0.364 - ETA: 0s - loss: 9.1119 - acc: 0.365 - ETA: 0s - loss: 9.0988 - acc: 0.367 - ETA: 0s - loss: 9.0574 - acc: 0.369 - ETA: 0s - loss: 9.0271 - acc: 0.370 - ETA: 0s - loss: 9.0056 - acc: 0.371 - ETA: 0s - loss: 9.0217 - acc: 0.370 - ETA: 0s - loss: 8.9943 - acc: 0.372 - ETA: 0s - loss: 9.0159 - acc: 0.371 - ETA: 0s - loss: 8.9833 - acc: 0.373 - ETA: 0s - loss: 8.9810 - acc: 0.373 - ETA: 0s - loss: 8.9479 - acc: 0.3741Epoch 00002: val_loss improved from 9.46505 to 9.04601, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 8.9493 - acc: 0.3743 - val_loss: 9.0460 - val_acc: 0.3521
Epoch 4/20
6560/6680 [=====>.] - ETA: 1s - loss: 6.7980 - acc: 0.450 - ETA: 1s - loss: 9.0188 - acc: 0.375 - ETA: 1s - loss: 9.0388 - acc: 0.380 - ETA: 1s - loss: 8.7868 - acc: 0.400 - ETA: 1s - loss: 8.7770 - acc: 0.406 - ETA: 1s - loss: 8.7482 - acc: 0.407 - ETA: 1s - loss: 8.5334 - acc: 0.417 - ETA: 1s - loss: 8.5241 - acc: 0.421 - ETA: 1s - loss: 8.4768 - acc: 0.422 - ETA: 1s - loss: 8.5492 - acc: 0.421 - ETA: 1s - loss: 8.6288 - acc: 0.417 - ETA: 1s - loss: 8.6605 - acc: 0.417 - ETA: 1s - loss: 8.6457 - acc: 0.417 - ETA: 1s - loss: 8.6473 - acc: 0.419 - ETA: 1s - loss: 8.6561 - acc: 0.418 - ETA: 1s - loss: 8.6351 - acc: 0.420 - ETA: 1s - loss: 8.6178 - acc: 0.420 - ETA: 1s - loss: 8.6343 - acc: 0.419 - ETA: 1s - loss: 8.6158 - acc: 0.420 - ETA: 0s - loss: 8.6403 - acc: 0.418 - ETA: 0s - loss: 8.7058 - acc: 0.415 - ETA: 0s - loss: 8.6773 - acc: 0.416 - ETA: 0s - loss: 8.6565 - acc: 0.417 - ETA: 0s - loss: 8.6232 - acc: 0.419 - ETA: 0s - loss: 8.6529 - acc: 0.418 - ETA: 0s - loss: 8.6425 - acc: 0.418 - ETA: 0s - loss: 8.6466 - acc: 0.417 - ETA: 0s - loss: 8.6242 - acc: 0.419 - ETA: 0s - loss: 8.6405 - acc: 0.417 - ETA: 0s - loss: 8.6109 - acc: 0.419 - ETA: 0s - loss: 8.6104 - acc: 0.419 - ETA: 0s - loss: 8.6264 - acc: 0.418 - ETA: 0s - loss: 8.6046 - acc: 0.419 - ETA: 0s - loss: 8.6239 - acc: 0.418 - ETA: 0s - loss: 8.6266 - acc: 0.418 - ETA: 0s - loss: 8.6238 - acc: 0.418 - ETA: 0s - loss: 8.6328 - acc: 0.418 - ETA: 0s - loss: 8.6433 - acc: 0.4169Epoch 00003: val_loss did not improve
6680/6680 [=====] - 2s - loss: 8.6633 - acc: 0.4159 - val_loss: 9.0568 - val_acc: 0.3545
Epoch 5/20
6620/6680 [=====>.] - ETA: 1s - loss: 8.3845 - acc: 0.450 - ETA: 1s - loss: 8.4802 - acc: 0.440 - ETA: 1s - loss: 8.4250 - acc: 0.444 - ETA: 1s - loss: 8.4208 - acc: 0.448 - ETA: 1s - loss: 8.3177 - acc: 0.451 - ETA: 1s - loss: 8.3987 - acc: 0.446 - ETA: 1s - loss: 8.3554 - acc: 0.451 - ETA: 1s - loss: 8.5559 - acc: 0.436 - ETA: 1s - loss: 8.5552 - acc: 0.436 - ETA: 1s - loss: 8.5993 - acc: 0.432 - ETA: 1s - loss: 8.5933 - acc: 0.434 - ETA: 1s - loss: 8.5378 - acc: 0.436 - ETA: 1s - loss: 8.5135 - acc: 0.438 - ETA: 1s - loss: 8.5821 - acc: 0.434 - ETA: 1s - loss: 8.5691 - acc: 0.435 - ETA: 1s - loss: 8.5572 - acc: 0.435 - ETA: 1s - loss: 8.5638 - acc: 0.435 - ETA: 1s - loss: 8.5603 - acc: 0.435 - ETA: 1s - loss: 8.5183 - acc: 0.439 - ETA: 0s - loss: 8.5354 - acc: 0.438 - ETA: 0s - loss: 8.5122 - acc: 0.440 - ETA: 0s - loss: 8.4722 - acc: 0.442 - ETA: 0s - loss: 8.4342 - acc: 0.445 - ETA: 0s - loss: 8.4796 - acc: 0.442 - ETA: 0s - loss: 8.4918 - acc: 0.441 - ETA: 0s - loss: 8.5309 - acc: 0.439 - ETA: 0s - loss: 8.5489 - acc: 0.438 - ETA: 0s - loss: 8.5678 - acc: 0.437 - ETA: 0s - loss: 8.5391 - acc: 0.438 - ETA: 0s - loss: 8.5163 - acc: 0.440 - ETA: 0s - loss: 8.5607 - acc: 0.437 - ETA: 0s - loss: 8.5402 - acc: 0.438 - ETA: 0s - loss: 8.5407 - acc: 0.438 - ETA: 0s - loss: 8.5523 - acc: 0.438 - ETA: 0s - loss: 8.5649 - acc: 0.437 - ETA: 0s - loss: 8.5463 - acc: 0.438 - ETA: 0s - loss: 8.5576 - acc: 0.437 - ETA: 0s - loss: 8.5535 - acc: 0.4372Epoch 00004: val_loss improved from 9.04601 to 8.91272, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 8.5468 - acc: 0.4379 - val_loss: 8.9127 - val_acc: 0.3832
Epoch 6/20
6620/6680 [=====>.] - ETA: 1s - loss: 9.8030 - acc: 0.350 - ETA: 1s - loss: 8.2775 - acc: 0.470 - ETA: 1s - loss: 8.6088 - acc: 0.452 - ETA: 1s - loss: 8.5059 - acc: 0.458 - ETA: 1s - loss: 8.4023 - acc: 0.467 - ETA: 1s - loss: 8.4950 - acc: 0.462 - ETA: 1s - loss: 8.4614 - acc: 0.463 - ETA: 1s - loss: 8.5813 - acc: 0.454 - ETA: 1s - loss: 8.5174 - acc: 0.456 - ETA: 1s - loss: 8.4461 - acc: 0.460 - ETA: 1s - loss: 8.4296 - acc: 0.460 - ETA: 1s - loss: 8.3884 - acc: 0.462 - ETA: 1s - loss: 8.3302 - acc: 0.465 - ETA: 1s - loss: 8.3644 - acc: 0.462 - ETA: 1s - loss: 8.3728 - acc: 0.461 - ETA: 1s - loss: 8.3442 - acc: 0.463 - ETA: 1s - loss: 8.3565 - acc: 0.462 - ETA: 1s - loss: 8.3539 - acc: 0.463 - ETA: 1s - loss: 8.4061 - acc: 0.458 - ETA: 0s - loss: 8.4009 - acc: 0.458 - ETA: 0s - loss: 8.4673 - acc: 0.454 - ETA: 0s - loss: 8.4922 - acc: 0.453 - ETA: 0s - loss: 8.5188 - acc: 0.450 - ETA: 0s - loss: 8.5024 - acc: 0.450 - ETA: 0s - loss: 8.4997 - acc: 0.450 - ETA: 0s - loss: 8.5198 - acc: 0.449 - ETA: 0s - loss: 8.5478 - acc: 0.447 - ETA: 0s - loss: 8.5751 - acc: 0.446 - ETA: 0s - loss: 8.5656 - acc: 0.446 - ETA: 0s - loss: 8.5788 - acc: 0.445 - ETA: 0s - loss: 8.6061 - acc: 0.442 - ETA: 0s - loss: 8.5926 - acc: 0.443 - ETA: 0s - loss: 8.5938 - acc: 0.442 - ETA: 0s - loss: 8.5824 - acc: 0.443 - ETA: 0s - loss: 8.5751 - acc: 0.444 - ETA: 0s - loss: 8.5410 - acc: 0.446 - ETA: 0s - loss: 8.5057 - acc: 0.448 - ETA: 0s - loss: 8.5100 - acc: 0.448 - ETA: 0s - loss: 8.4978 - acc: 0.4492Epoch 00005: val_loss did not improve
6680/6680 [=====] - 2s - loss: 8.4874 - acc: 0.4499 - val_loss: 8.9467 - val_acc: 0.3832

Epoch 7/20

6560/6680 [=====>.] - ETA: 1s - loss: 6.4820 - acc: 0.600 - ETA: 2s - loss: 8.1816 - acc: 0.483 - ETA: 1s - loss: 8.1719 - acc: 0.479 - ETA: 1s - loss: 8.1531 - acc: 0.482 - ETA: 1s - loss: 8.1969 - acc: 0.475 - ETA: 1s - loss: 8.3404 - acc: 0.467 - ETA: 1s - loss: 8.3976 - acc: 0.461 - ETA: 1s - loss: 8.5440 - acc: 0.451 - ETA: 1s - loss: 8.5548 - acc: 0.452 - ETA: 1s - loss: 8.4813 - acc: 0.456 - ETA: 1s - loss: 8.3839 - acc: 0.461 - ETA: 1s - loss: 8.3233 - acc: 0.465 - ETA: 1s - loss: 8.3922 - acc: 0.461 - ETA: 1s - loss: 8.3745 - acc: 0.463 - ETA: 1s - loss: 8.4189 - acc: 0.461 - ETA: 1s - loss: 8.4300 - acc: 0.461 - ETA: 1s - loss: 8.4966 - acc: 0.457 - ETA: 1s - loss: 8.4849 - acc: 0.458 - ETA: 1s - loss: 8.4563 - acc: 0.460 - ETA: 0s - loss: 8.5265 - acc: 0.455 - ETA: 0s - loss: 8.5776 - acc: 0.451 - ETA: 0s - loss: 8.5929 - acc: 0.451 - ETA: 0s - loss: 8.5952 - acc: 0.451 - ETA: 0s - loss: 8.6356 - acc: 0.449 - ETA: 0s - loss: 8.5926 - acc: 0.451 - ETA: 0s - loss: 8.6007 - acc: 0.450 - ETA: 0s - loss: 8.5884 - acc: 0.450 - ETA: 0s - loss: 8.5886 - acc: 0.451 - ETA: 0s - loss: 8.5742 - acc: 0.452 - ETA: 0s - loss: 8.5820 - acc: 0.451 - ETA: 0s - loss: 8.5827 - acc: 0.450 - ETA: 0s - loss: 8.5716 - acc: 0.451 - ETA: 0s - loss: 8.5605 - acc: 0.451 - ETA: 0s - loss: 8.5318 - acc: 0.453 - ETA: 0s - loss: 8.5080 - acc: 0.454 - ETA: 0s - loss: 8.5056 - acc: 0.454 - ETA: 0s - loss: 8.4832 - acc: 0.455 - ETA: 0s - loss: 8.4597 - acc: 0.4572Epoch 00006: val_loss improved from 8.91272 to 8.87166, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 8.4455 - acc: 0.4578 - val_loss: 8.8717 - val_acc: 0.3760

Epoch 8/20

6580/6680 [=====>.] - ETA: 2s - loss: 10.4770 - acc: 0.35 - ETA: 2s - loss: 8.3194 - acc: 0.4800 - ETA: 2s - loss: 8.7988 - acc: 0.444 - ETA: 1s - loss: 8.6900 - acc: 0.450 - ETA: 1s - loss: 8.4766 - acc: 0.458 - ETA: 1s - loss: 8.6567 - acc: 0.446 - ETA: 1s - loss: 8.6416 - acc: 0.446 - ETA: 1s - loss: 8.5596 - acc: 0.450 - ETA: 1s - loss: 8.5821 - acc: 0.450 - ETA: 1s - loss: 8.4451 - acc: 0.458 - ETA: 1s - loss: 8.3628 - acc: 0.461 - ETA: 1s - loss: 8.3286 - acc: 0.461 - ETA: 1s - loss: 8.2635 - acc: 0.466 - ETA: 1s - loss: 8.3613 - acc: 0.460 - ETA: 1s - loss: 8.3319 - acc: 0.462 - ETA: 1s - loss: 8.3071 - acc: 0.463 - ETA: 1s - loss: 8.3021 - acc: 0.463 - ETA: 1s - loss: 8.3236 - acc: 0.460 - ETA: 1s - loss: 8.3829 - acc: 0.455 - ETA: 0s - loss: 8.3829 - acc: 0.455 - ETA: 0s - loss: 8.3713 - acc: 0.455 - ETA: 0s - loss: 8.3755 - acc: 0.455 - ETA: 0s - loss: 8.4018 - acc: 0.454 - ETA: 0s - loss: 8.3893 - acc: 0.455 - ETA: 0s - loss: 8.3766 - acc: 0.457 - ETA: 0s - loss: 8.4087 - acc: 0.455 - ETA: 0s - loss: 8.4126 - acc: 0.455 - ETA: 0s - loss: 8.3720 - acc: 0.458 - ETA: 0s - loss: 8.4039 - acc: 0.455 - ETA: 0s - loss: 8.3843 - acc: 0.457 - ETA: 0s - loss: 8.3790 - acc: 0.456 - ETA: 0s - loss: 8.3516 - acc: 0.458 - ETA: 0s - loss: 8.3336 - acc: 0.459 - ETA: 0s - loss: 8.2937 - acc: 0.462 - ETA: 0s - loss: 8.2978 - acc: 0.462 - ETA: 0s - loss: 8.2847 - acc: 0.463 - ETA: 0s - loss: 8.2876 - acc: 0.462 - ETA: 0s - loss: 8.3058 - acc: 0.4620Epoch 00007: val_loss improved from 8.87166 to 8.70881, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 8.2811 - acc: 0.4636 - val_loss: 8.7088 - val_acc: 0.3868

Epoch 9/20

6580/6680 [=====>.] - ETA: 1s - loss: 10.6722 - acc: 0.30 - ETA: 1s - loss: 7.5644 - acc: 0.5150 - ETA: 1s - loss: 8.0827 - acc: 0.481 - ETA: 1s - loss: 8.4036 - acc: 0.462 - ETA: 1s - loss: 8.2694 - acc: 0.471 - ETA: 1s - loss: 8.0436 - acc: 0.484 - ETA: 1s - loss: 7.9665 - acc: 0.489 - ETA: 1s - loss: 8.1457 - acc: 0.479 - ETA: 1s - loss: 8.2077 - acc: 0.477 - ETA: 1s - loss: 8.2490 - acc: 0.475 - ETA: 1s - loss: 8.2282 - acc: 0.475 - ETA: 1s - loss: 8.1758 - acc: 0.478 - ETA: 1s - loss: 8.1248 - acc: 0.479 - ETA: 1s - loss: 8.1171 - acc: 0.479 - ETA: 1s - loss: 8.1310 - acc: 0.478 - ETA: 1s - loss: 8.1101 - acc: 0.479 - ETA: 1s - loss: 8.0907 - acc: 0.481 - ETA: 1s - loss: 8.1267 - acc: 0.477 - ETA: 1s - loss: 8.1518 - acc: 0.476 - ETA: 0s - loss: 8.1126 - acc: 0.478 - ETA: 0s - loss: 8.0407 - acc: 0.482 - ETA: 0s - loss: 8.0408 - acc: 0.481 - ETA: 0s - loss: 8.0473 - acc: 0.481 - ETA: 0s - loss: 8.0521 - acc: 0.481 - ETA: 0s - loss: 8.0576 - acc: 0.480 - ETA: 0s - loss: 8.0362 - acc: 0.481 - ETA: 0s - loss: 8.0941 - acc: 0.478 - ETA: 0s - loss: 8.0708 - acc: 0.479 - ETA: 0s - loss: 8.0613 - acc: 0.480 - ETA: 0s - loss: 8.0566 - acc: 0.480 - ETA: 0s - loss: 8.0515 - acc: 0.479 - ETA: 0s - loss: 8.0798 - acc: 0.478 - ETA: 0s - loss: 8.0756 - acc: 0.478 - ETA: 0s - loss: 8.0627 - acc: 0.478 - ETA: 0s - loss: 8.0797 - acc: 0.477 - ETA: 0s - loss: 8.0616 - acc: 0.479 - ETA: 0s - loss: 8.0447 - acc: 0.480 - ETA: 0s - loss: 8.0611 - acc: 0.4789Epoch 00008: val_loss improved from 8.70881 to 8.50941, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 8.0678 - acc: 0.4786 - val_loss: 8.5094 - val_acc: 0.4000

Epoch 10/20

6500/6680 [=====>.] - ETA: 2s - loss: 7.4881 - acc: 0.500 - ETA: 1s - loss: 7.4293 - acc: 0.525 - ETA: 1s - loss: 7.8902 - acc: 0.494 - ETA: 1s - loss: 7.8422 - acc: 0.498 - ETA: 1s - loss: 7.9858 - acc: 0.491 - ETA: 1s - loss: 8.2800 - acc: 0.470 - ETA: 1s - loss: 8.0709 - acc: 0.485 - ETA: 1s - loss: 7.9868 - acc: 0.491 - ETA: 1s - loss: 7.9597 - acc: 0.493 - ETA: 1s - loss: 8.0413 - acc: 0.488 - ETA: 1s - loss: 8.0502 - acc: 0.488 - ETA: 1s - loss: 8.0687 - acc: 0.488 - ETA: 1s - loss: 8.0584 - acc: 0.488 - ETA: 1s - loss: 8.1136 - acc: 0.485 - ETA: 1s - loss: 8.0916 - acc: 0.487 - ETA: 1s - loss: 8.0417 - acc: 0.490 - ETA: 1s - loss: 7.9613 - acc: 0.496 - ETA: 1s - loss: 8.0127 - acc: 0.492 - ETA: 0s - loss: 8.0872 - acc: 0.487 - ETA: 0s - loss: 8.0304 - acc: 0.491 - ETA: 0s - loss: 8.0275 - acc: 0.492 - ETA: 0s - loss: 7.9755 - acc: 0.495 - ETA: 0s - loss: 7.9789 - acc: 0.494 - ETA: 0s - loss: 7.9558 - acc: 0.495 - ETA: 0s - loss: 7.9329 - acc: 0.496 - ETA: 0s - loss: 7.9248 - acc: 0.497 - ETA: 0s - loss: 7.8928 - acc: 0.500 - ETA: 0s - loss: 7.9097 - acc: 0.499 - ETA: 0s - loss: 7.9152 - acc: 0.498 - ETA: 0s - loss: 7.9112 - acc: 0.499 - ETA: 0s - loss: 7.9289 - acc: 0.498 - ETA: 0s - loss: 7.9368 - acc: 0.498 - ETA: 0s - loss: 7.9690 - acc: 0.496 - ETA: 0s - loss: 7.9563 - acc: 0.497 - ETA: 0s - loss: 7.9600 - acc: 0.496 - ETA: 0s - loss: 7.9626 - acc: 0.496 - ETA: 0s - loss: 7.9754 - acc: 0.4954Epoch 00009: val_loss improved from 8.50941 to 8.48626, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 7.9649 - acc: 0.4961 - val_loss: 8.4863 - val_acc: 0.4036

Epoch 11/20

6600/6680 [=====>.] - ETA: 1s - loss: 8.8665 - acc: 0.450 - ETA: 1s - loss: 7.9221 - acc: 0.505 - ETA: 1s - loss: 8.2297 - acc: 0.481 - ETA: 1s - loss: 7.9973 - acc: 0.494 - ETA: 1s - loss: 8.0639 - acc: 0.490 - ETA: 1s - loss: 7.9940 - acc: 0.496 - ETA: 1s - loss: 8.1086 - acc: 0.490 - ETA: 1s - loss: 8.0683 - acc: 0.493 - ETA: 1s - loss: 8.1028 - acc: 0.490 - ETA: 1s - loss: 7.9874 - acc: 0.497 - ETA: 1s - loss: 7.9422 - acc: 0.500 - ETA: 1s - loss: 7.9550 - acc: 0.499 - ETA: 1s - loss: 7.9417 - acc: 0.500 - ETA: 1s - loss: 8.0439 - acc: 0.493 - ETA: 1s - loss: 7.9972 - acc: 0.496 - ETA: 1s - loss: 7.9858 - acc: 0.496 - ETA: 1s - loss: 7.9694 - acc: 0.497 - ETA: 1s - loss: 7.9100 - acc: 0.501 - ETA: 0s - loss: 7.8853 - acc: 0.502 - ETA: 0s - loss: 7.8619 - acc: 0.504 - ETA: 0s - loss: 7.8945 - acc: 0.502 - ETA: 0s - loss: 7.9569 - acc: 0.498 - ETA: 0s - loss: 7.9266 - acc: 0.500 - ETA: 0s - loss: 7.9450 - acc: 0.499 - ETA: 0s - loss: 7.9318 - acc: 0.500 - ETA: 0s - loss: 7.9101 - acc: 0.501 - ETA: 0s - loss: 7.9070 - acc: 0.501 - ETA: 0s - loss: 7.9095 - acc: 0.501 - ETA: 0s - loss: 7.9333 - acc: 0.500 - ETA: 0s - loss: 7.9751 - acc: 0.497 - ETA: 0s - loss: 7.9740 - acc: 0.497 - ETA: 0s - loss:

7.9590 - acc: 0.498 - ETA: 0s - loss: 7.9395 - acc: 0.499 - ETA: 0s - loss: 7.9348 - acc: 0.499 - ETA: 0s - loss: 7.9305 - acc: 0.500 - ETA: 0s - loss: 7.9546 - acc: 0.498 - ETA: 0s - loss: 7.9661 - acc: 0.497 - ETA: 0s - loss: 7.9318 - acc: 0.4994Epoch 00010: val_loss improved from 8.48626 to 8.38176, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 7.9357 - acc: 0.4993 - val_loss: 8.3818 - val_acc: 0.4108
Epoch 12/20
6600/6680 [=====>.] - ETA: 1s - loss: 7.1883 - acc: 0.500 - ETA: 1s - loss: 7.2288 - acc: 0.540 - ETA: 1s - loss: 7.4218 - acc: 0.530 - ETA: 1s - loss: 7.4381 - acc: 0.524 - ETA: 1s - loss: 7.9043 - acc: 0.495 - ETA: 1s - loss: 7.9544 - acc: 0.488 - ETA: 1s - loss: 8.0801 - acc: 0.481 - ETA: 1s - loss: 8.0776 - acc: 0.484 - ETA: 1s - loss: 7.8757 - acc: 0.495 - ETA: 1s - loss: 7.8034 - acc: 0.498 - ETA: 1s - loss: 7.8435 - acc: 0.496 - ETA: 1s - loss: 7.7665 - acc: 0.497 - ETA: 1s - loss: 7.7181 - acc: 0.501 - ETA: 1s - loss: 7.7746 - acc: 0.498 - ETA: 1s - loss: 7.7971 - acc: 0.497 - ETA: 1s - loss: 7.8922 - acc: 0.492 - ETA: 1s - loss: 7.8938 - acc: 0.492 - ETA: 1s - loss: 7.8319 - acc: 0.495 - ETA: 1s - loss: 7.8514 - acc: 0.494 - ETA: 1s - loss: 7.8894 - acc: 0.491 - ETA: 0s - loss: 7.8619 - acc: 0.493 - ETA: 0s - loss: 7.8283 - acc: 0.495 - ETA: 0s - loss: 7.7886 - acc: 0.498 - ETA: 0s - loss: 7.7462 - acc: 0.502 - ETA: 0s - loss: 7.7410 - acc: 0.502 - ETA: 0s - loss: 7.7184 - acc: 0.504 - ETA: 0s - loss: 7.7209 - acc: 0.504 - ETA: 0s - loss: 7.7242 - acc: 0.503 - ETA: 0s - loss: 7.7227 - acc: 0.503 - ETA: 0s - loss: 7.7569 - acc: 0.500 - ETA: 0s - loss: 7.7445 - acc: 0.501 - ETA: 0s - loss: 7.7605 - acc: 0.500 - ETA: 0s - loss: 7.7830 - acc: 0.498 - ETA: 0s - loss: 7.7935 - acc: 0.498 - ETA: 0s - loss: 7.7970 - acc: 0.497 - ETA: 0s - loss: 7.7813 - acc: 0.497 - ETA: 0s - loss: 7.7833 - acc: 0.497 - ETA: 0s - loss: 7.7470 - acc: 0.499 - ETA: 0s - loss: 7.7443 - acc: 0.4997Epoch 00011: val_loss improved from 8.38176 to 8.17250, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 7.7466 - acc: 0.4997 - val_loss: 8.1725 - val_acc: 0.4204
Epoch 13/20
6640/6680 [=====>.] - ETA: 1s - loss: 9.6722 - acc: 0.400 - ETA: 1s - loss: 6.9098 - acc: 0.550 - ETA: 1s - loss: 6.9477 - acc: 0.550 - ETA: 1s - loss: 6.9014 - acc: 0.551 - ETA: 1s - loss: 7.1732 - acc: 0.535 - ETA: 1s - loss: 7.0921 - acc: 0.543 - ETA: 1s - loss: 7.2262 - acc: 0.533 - ETA: 1s - loss: 7.1260 - acc: 0.539 - ETA: 1s - loss: 7.2891 - acc: 0.530 - ETA: 1s - loss: 7.4229 - acc: 0.522 - ETA: 1s - loss: 7.5483 - acc: 0.514 - ETA: 1s - loss: 7.5109 - acc: 0.516 - ETA: 1s - loss: 7.5704 - acc: 0.511 - ETA: 1s - loss: 7.6180 - acc: 0.509 - ETA: 1s - loss: 7.5990 - acc: 0.510 - ETA: 1s - loss: 7.5398 - acc: 0.514 - ETA: 1s - loss: 7.5231 - acc: 0.514 - ETA: 1s - loss: 7.4655 - acc: 0.518 - ETA: 0s - loss: 7.4202 - acc: 0.520 - ETA: 0s - loss: 7.4510 - acc: 0.519 - ETA: 0s - loss: 7.4339 - acc: 0.519 - ETA: 0s - loss: 7.4776 - acc: 0.515 - ETA: 0s - loss: 7.5232 - acc: 0.512 - ETA: 0s - loss: 7.5331 - acc: 0.511 - ETA: 0s - loss: 7.5539 - acc: 0.510 - ETA: 0s - loss: 7.5160 - acc: 0.512 - ETA: 0s - loss: 7.5036 - acc: 0.513 - ETA: 0s - loss: 7.4946 - acc: 0.513 - ETA: 0s - loss: 7.4863 - acc: 0.514 - ETA: 0s - loss: 7.5014 - acc: 0.514 - ETA: 0s - loss: 7.4869 - acc: 0.515 - ETA: 0s - loss: 7.4504 - acc: 0.517 - ETA: 0s - loss: 7.4592 - acc: 0.517 - ETA: 0s - loss: 7.4730 - acc: 0.516 - ETA: 0s - loss: 7.4904 - acc: 0.515 - ETA: 0s - loss: 7.5158 - acc: 0.514 - ETA: 0s - loss: 7.5319 - acc: 0.512 - ETA: 0s - loss: 7.5507 - acc: 0.5119Epoch 00012: val_loss improved from 8.17250 to 8.06443, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 7.5354 - acc: 0.5127 - val_loss: 8.0644 - val_acc: 0.4335
Epoch 14/20
6560/6680 [=====>.] - ETA: 1s - loss: 8.1082 - acc: 0.450 - ETA: 1s - loss: 6.4584 - acc: 0.595 - ETA: 1s - loss: 7.0525 - acc: 0.557 - ETA: 1s - loss: 7.3474 - acc: 0.541 - ETA: 1s - loss: 7.2744 - acc: 0.541 - ETA: 1s - loss: 7.4115 - acc: 0.531 - ETA: 1s - loss: 7.5520 - acc: 0.522 - ETA: 1s - loss: 7.4596 - acc: 0.525 - ETA: 1s - loss: 7.5450 - acc: 0.521 - ETA: 1s - loss: 7.5132 - acc: 0.524 - ETA: 1s - loss: 7.5181 - acc: 0.523 - ETA: 1s - loss: 7.4515 - acc: 0.527 - ETA: 1s - loss: 7.5048 - acc: 0.523 - ETA: 1s - loss: 7.5490 - acc: 0.520 - ETA: 1s - loss: 7.4917 - acc: 0.524 - ETA: 1s - loss: 7.3816 - acc: 0.530 - ETA: 1s - loss: 7.3938 - acc: 0.529 - ETA: 1s - loss: 7.3284 - acc: 0.533 - ETA: 1s - loss: 7.3266 - acc: 0.533 - ETA: 1s - loss: 7.3161 - acc: 0.534 - ETA: 0s - loss: 7.3478 - acc: 0.532 - ETA: 0s - loss: 7.3503 - acc: 0.532 - ETA: 0s - loss: 7.3719 - acc: 0.530 - ETA: 0s - loss: 7.3990 - acc: 0.527 - ETA: 0s - loss: 7.4088 - acc: 0.527 - ETA: 0s - loss: 7.3971 - acc: 0.527 - ETA: 0s - loss: 7.3971 - acc: 0.527 - ETA: 0s - loss: 7.4224 - acc: 0.526 - ETA: 0s - loss: 7.4235 - acc: 0.526 - ETA: 0s - loss: 7.4247 - acc: 0.525 - ETA: 0s - loss: 7.4256 - acc: 0.524 - ETA: 0s - loss: 7.4552 - acc: 0.522 - ETA: 0s - loss: 7.4654 - acc: 0.521 - ETA: 0s - loss: 7.4411 - acc: 0.522 - ETA: 0s - loss: 7.4713 - acc: 0.521 - ETA: 0s - loss: 7.4653 - acc: 0.522 - ETA: 0s - loss: 7.4395 - acc: 0.523 - ETA: 0s - loss: 7.4319 - acc: 0.5241Epoch 00013: val_loss improved from 8.06443 to 8.02562, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 7.4251 - acc: 0.5243 - val_loss: 8.0256 - val_acc: 0.4383
Epoch 15/20
6500/6680 [=====>.] - ETA: 2s - loss: 8.0775 - acc: 0.500 - ETA: 1s - loss: 7.3420 - acc: 0.525 - ETA: 1s - loss: 7.2314 - acc: 0.528 - ETA: 1s - loss: 6.7872 - acc: 0.558 - ETA: 1s - loss: 6.8002 - acc: 0.556 - ETA: 1s - loss: 6.9071 - acc: 0.554 - ETA: 1s - loss: 6.8172 - acc: 0.561 - ETA: 1s - loss: 6.9067 - acc: 0.557 - ETA: 1s - loss: 7.0882 - acc: 0.545 - ETA: 1s - loss: 7.1778 - acc: 0.540 - ETA: 1s - loss: 7.1585 - acc: 0.540 - ETA: 1s - loss: 7.1535 - acc: 0.541 - ETA: 1s - loss: 7.1780 - acc: 0.540 - ETA: 1s - loss: 7.2288 - acc: 0.537 - ETA: 1s - loss: 7.2207 - acc: 0.538 - ETA: 1s - loss: 7.1874 - acc: 0.541 - ETA: 1s - loss: 7.2698 - acc: 0.536 - ETA: 1s - loss: 7.2151 - acc: 0.539 - ETA: 0s - loss: 7.2830 - acc: 0.535 - ETA: 0s - loss: 7.2851 - acc: 0.535 - ETA: 0s - loss: 7.2742 - acc: 0.536 - ETA: 0s - loss: 7.2719 - acc: 0.536 - ETA: 0s - loss: 7.2341 - acc: 0.538 - ETA: 0s - loss: 7.2273 - acc: 0.538 - ETA: 0s - loss: 7.2345 - acc: 0.538 - ETA: 0s - loss: 7.2281 - acc: 0.538 - ETA: 0s - loss: 7.2343 - acc: 0.538 - ETA: 0s - loss: 7.2357 - acc: 0.538 - ETA: 0s - loss: 7.2394 - acc: 0.538 - ETA: 0s - loss: 7.2618 - acc: 0.537 - ETA: 0s - loss: 7.2980 - acc: 0.535 - ETA: 0s - loss: 7.2773 - acc: 0.536 - ETA: 0s - loss: 7.3036 - acc: 0.534 - ETA: 0s - loss: 7.3113 - acc: 0.534 - ETA: 0s - loss: 7.3249 - acc: 0.533 - ETA: 0s - loss: 7.3351 - acc: 0.532 - ETA: 0s - loss: 7.3180 - acc: 0.5335Epoch 00014: val_loss improved from 8.02562 to 7.91395, saving model to saved_models/weights.best.VGG16.hdf5
6680/6680 [=====] - 2s - loss: 7.3566 - acc: 0.5311 - val_loss: 7.9139 - val_acc: 0.4407
Epoch 16/20
6660/6680 [=====>.] - ETA: 1s - loss: 8.8659 - acc: 0.450 - ETA: 1s - loss: 6.7651 - acc: 0.575 - ETA: 1s - loss: 7.1251 - acc: 0.555 - ETA: 1s - loss: 6.8347 - acc: 0.567 - ETA: 1s - loss: 7.0633 - acc: 0.552 - ETA: 1s - loss: 7.1193 - acc: 0.550 - ETA: 1s - loss: 7.3787 - acc: 0.533 - ETA: 1s - loss: 7.3912 - acc: 0.531 - ETA: 1s - loss: 7.5319 - acc: 0.521 - ETA: 1s - loss: 7.4629 - acc: 0.526 - ETA: 1s - loss: 7.5048 - acc: 0.524 - ETA: 1s - loss: 7.4984 - acc: 0.526 - ETA: 1s - loss: 7.4079 - acc:

0.532 - ETA: 1s - loss: 7.3979 - acc: 0.532 - ETA: 1s - loss: 7.3823 - acc: 0.534 - ETA: 1s - loss: 7.3518 - acc: 0.536 - ETA: 1s - loss: 7.3129 - acc: 0.538 - ETA: 1s - loss: 7.3210 - acc: 0.538 - ETA: 0s - loss: 7.2829 - acc: 0.541 - ETA: 0s - loss: 7.2581 - acc: 0.543 - ETA: 0s - loss: 7.2212 - acc: 0.545 - ETA: 0s - loss: 7.2374 - acc: 0.543 - ETA: 0s - loss: 7.2596 - acc: 0.541 - ETA: 0s - loss: 7.2893 - acc: 0.540 - ETA: 0s - loss: 7.3221 - acc: 0.538 - ETA: 0s - loss: 7.3220 - acc: 0.537 - ETA: 0s - loss: 7.3256 - acc: 0.536 - ETA: 0s - loss: 7.3165 - acc: 0.537 - ETA: 0s - loss: 7.3060 - acc: 0.538 - ETA: 0s - loss: 7.2489 - acc: 0.542 - ETA: 0s - loss: 7.2519 - acc: 0.541 - ETA: 0s - loss: 7.2776 - acc: 0.539 - ETA: 0s - loss: 7.3126 - acc: 0.537 - ETA: 0s - loss: 7.3310 - acc: 0.535 - ETA: 0s - loss: 7.3455 - acc: 0.535 - ETA: 0s - loss: 7.3433 - acc: 0.535 - ETA: 0s - loss: 7.3212 - acc: 0.536 - ETA: 0s - loss: 7.3080 - acc: 0.5374Epoch 00015: val_loss improved from 7.91395 to 7.89194, saving model to saved_models/weights.best.VGG16.hdf5 6680/6680 [=====] - 2s - loss: 7.3152 - acc: 0.5368 - val_loss: 7.8919 - val_acc: 0.4395

Epoch 17/20
6600/6680 [=====>.] - ETA: 1s - loss: 7.2535 - acc: 0.550 - ETA: 1s - loss: 7.9263 - acc: 0.500 - ETA: 1s - loss: 7.7358 - acc: 0.515 - ETA: 1s - loss: 7.5855 - acc: 0.523 - ETA: 1s - loss: 7.1793 - acc: 0.550 - ETA: 1s - loss: 7.1643 - acc: 0.551 - ETA: 1s - loss: 7.1500 - acc: 0.552 - ETA: 1s - loss: 7.1019 - acc: 0.556 - ETA: 1s - loss: 7.2647 - acc: 0.546 - ETA: 1s - loss: 7.2756 - acc: 0.545 - ETA: 1s - loss: 7.2914 - acc: 0.545 - ETA: 1s - loss: 7.3129 - acc: 0.544 - ETA: 1s - loss: 7.3971 - acc: 0.538 - ETA: 1s - loss: 7.3192 - acc: 0.542 - ETA: 1s - loss: 7.4025 - acc: 0.537 - ETA: 1s - loss: 7.3821 - acc: 0.538 - ETA: 1s - loss: 7.3592 - acc: 0.539 - ETA: 1s - loss: 7.3964 - acc: 0.537 - ETA: 1s - loss: 7.3576 - acc: 0.540 - ETA: 0s - loss: 7.3970 - acc: 0.537 - ETA: 0s - loss: 7.4170 - acc: 0.535 - ETA: 0s - loss: 7.3787 - acc: 0.537 - ETA: 0s - loss: 7.3695 - acc: 0.537 - ETA: 0s - loss: 7.3661 - acc: 0.537 - ETA: 0s - loss: 7.3486 - acc: 0.538 - ETA: 0s - loss: 7.3430 - acc: 0.538 - ETA: 0s - loss: 7.3503 - acc: 0.537 - ETA: 0s - loss: 7.3520 - acc: 0.537 - ETA: 0s - loss: 7.3389 - acc: 0.538 - ETA: 0s - loss: 7.3178 - acc: 0.539 - ETA: 0s - loss: 7.2935 - acc: 0.541 - ETA: 0s - loss: 7.2866 - acc: 0.541 - ETA: 0s - loss: 7.2912 - acc: 0.541 - ETA: 0s - loss: 7.2880 - acc: 0.541 - ETA: 0s - loss: 7.2837 - acc: 0.542 - ETA: 0s - loss: 7.3016 - acc: 0.541 - ETA: 0s - loss: 7.2706 - acc: 0.542 - ETA: 0s - loss: 7.2894 - acc: 0.5412Epoch 00016: val_loss improved from 7.89194 to 7.85637, saving model to saved_models/weights.best.VGG16.hdf5 6680/6680 [=====] - 2s - loss: 7.2867 - acc: 0.5415 - val_loss: 7.8564 - val_acc: 0.4491

Epoch 18/20
6620/6680 [=====>.] - ETA: 2s - loss: 7.2532 - acc: 0.550 - ETA: 1s - loss: 7.2492 - acc: 0.545 - ETA: 1s - loss: 7.3269 - acc: 0.539 - ETA: 1s - loss: 7.3624 - acc: 0.539 - ETA: 1s - loss: 7.1866 - acc: 0.550 - ETA: 1s - loss: 7.0385 - acc: 0.559 - ETA: 1s - loss: 7.0973 - acc: 0.556 - ETA: 1s - loss: 7.1613 - acc: 0.552 - ETA: 1s - loss: 7.2498 - acc: 0.547 - ETA: 1s - loss: 7.2498 - acc: 0.546 - ETA: 1s - loss: 7.3160 - acc: 0.542 - ETA: 1s - loss: 7.3207 - acc: 0.541 - ETA: 1s - loss: 7.2703 - acc: 0.545 - ETA: 1s - loss: 7.2573 - acc: 0.546 - ETA: 1s - loss: 7.2749 - acc: 0.545 - ETA: 1s - loss: 7.3076 - acc: 0.543 - ETA: 1s - loss: 7.2280 - acc: 0.547 - ETA: 1s - loss: 7.2933 - acc: 0.543 - ETA: 1s - loss: 7.3619 - acc: 0.539 - ETA: 0s - loss: 7.3135 - acc: 0.542 - ETA: 0s - loss: 7.3292 - acc: 0.541 - ETA: 0s - loss: 7.3002 - acc: 0.543 - ETA: 0s - loss: 7.2943 - acc: 0.543 - ETA: 0s - loss: 7.2724 - acc: 0.544 - ETA: 0s - loss: 7.2505 - acc: 0.546 - ETA: 0s - loss: 7.2623 - acc: 0.545 - ETA: 0s - loss: 7.2447 - acc: 0.545 - ETA: 0s - loss: 7.2514 - acc: 0.544 - ETA: 0s - loss: 7.2291 - acc: 0.545 - ETA: 0s - loss: 7.2276 - acc: 0.545 - ETA: 0s - loss: 7.1792 - acc: 0.548 - ETA: 0s - loss: 7.2100 - acc: 0.546 - ETA: 0s - loss: 7.2142 - acc: 0.545 - ETA: 0s - loss: 7.2182 - acc: 0.545 - ETA: 0s - loss: 7.2219 - acc: 0.545 - ETA: 0s - loss: 7.2280 - acc: 0.545 - ETA: 0s - loss: 7.2513 - acc: 0.544 - ETA: 0s - loss: 7.2416 - acc: 0.5449Epoch 00017: val_loss improved from 7.85637 to 7.84609, saving model to saved_models/weights.best.VGG16.hdf5 6680/6680 [=====] - 2s - loss: 7.2514 - acc: 0.5443 - val_loss: 7.8461 - val_acc: 0.4431

Epoch 19/20
6660/6680 [=====>.] - ETA: 2s - loss: 5.6416 - acc: 0.650 - ETA: 1s - loss: 6.1251 - acc: 0.620 - ETA: 1s - loss: 6.7499 - acc: 0.578 - ETA: 1s - loss: 6.7280 - acc: 0.578 - ETA: 1s - loss: 6.8206 - acc: 0.571 - ETA: 1s - loss: 6.8572 - acc: 0.569 - ETA: 1s - loss: 7.0426 - acc: 0.558 - ETA: 1s - loss: 7.0356 - acc: 0.558 - ETA: 1s - loss: 7.0846 - acc: 0.556 - ETA: 1s - loss: 7.1138 - acc: 0.554 - ETA: 1s - loss: 7.1215 - acc: 0.552 - ETA: 1s - loss: 7.2383 - acc: 0.546 - ETA: 1s - loss: 7.2793 - acc: 0.543 - ETA: 1s - loss: 7.2536 - acc: 0.544 - ETA: 1s - loss: 7.2409 - acc: 0.545 - ETA: 1s - loss: 7.2545 - acc: 0.544 - ETA: 1s - loss: 7.2989 - acc: 0.542 - ETA: 1s - loss: 7.3174 - acc: 0.541 - ETA: 0s - loss: 7.3852 - acc: 0.537 - ETA: 0s - loss: 7.3891 - acc: 0.536 - ETA: 0s - loss: 7.3392 - acc: 0.539 - ETA: 0s - loss: 7.3733 - acc: 0.537 - ETA: 0s - loss: 7.3925 - acc: 0.536 - ETA: 0s - loss: 7.3950 - acc: 0.535 - ETA: 0s - loss: 7.3858 - acc: 0.536 - ETA: 0s - loss: 7.3949 - acc: 0.536 - ETA: 0s - loss: 7.3663 - acc: 0.537 - ETA: 0s - loss: 7.3795 - acc: 0.537 - ETA: 0s - loss: 7.3526 - acc: 0.538 - ETA: 0s - loss: 7.3278 - acc: 0.540 - ETA: 0s - loss: 7.2976 - acc: 0.541 - ETA: 0s - loss: 7.2838 - acc: 0.542 - ETA: 0s - loss: 7.2778 - acc: 0.543 - ETA: 0s - loss: 7.2809 - acc: 0.542 - ETA: 0s - loss: 7.2545 - acc: 0.544 - ETA: 0s - loss: 7.2483 - acc: 0.544 - ETA: 0s - loss: 7.2344 - acc: 0.545 - ETA: 0s - loss: 7.2254 - acc: 0.5464Epoch 00018: val_loss improved from 7.84609 to 7.80559, saving model to saved_models/weights.best.VGG16.hdf5 6680/6680 [=====] - 2s - loss: 7.2206 - acc: 0.5467 - val_loss: 7.8056 - val_acc: 0.4467

Epoch 20/20
6640/6680 [=====>.] - ETA: 1s - loss: 6.8208 - acc: 0.550 - ETA: 1s - loss: 7.2944 - acc: 0.540 - ETA: 1s - loss: 7.8707 - acc: 0.507 - ETA: 1s - loss: 7.9456 - acc: 0.500 - ETA: 1s - loss: 7.5380 - acc: 0.527 - ETA: 1s - loss: 7.5214 - acc: 0.527 - ETA: 1s - loss: 7.4225 - acc: 0.534 - ETA: 1s - loss: 7.3006 - acc: 0.541 - ETA: 1s - loss: 7.1925 - acc: 0.548 - ETA: 1s - loss: 7.1289 - acc: 0.553 - ETA: 1s - loss: 7.1345 - acc: 0.552 - ETA: 1s - loss: 7.1539 - acc: 0.551 - ETA: 1s - loss: 7.2084 - acc: 0.548 - ETA: 1s - loss: 7.1520 - acc: 0.551 - ETA: 1s - loss: 7.1865 - acc: 0.548 - ETA: 1s - loss: 7.1903 - acc: 0.547 - ETA: 1s - loss: 7.1914 - acc: 0.547 - ETA: 1s - loss: 7.1953 - acc: 0.546 - ETA: 1s - loss: 7.1611 - acc: 0.548 - ETA: 0s - loss: 7.2276 - acc: 0.544 - ETA: 0s - loss: 7.1569 - acc: 0.549 - ETA: 0s - loss: 7.1316 - acc: 0.551 - ETA: 0s - loss: 7.0881 - acc: 0.554 - ETA: 0s - loss: 7.0794 - acc: 0.554 - ETA: 0s - loss: 7.0751 - acc: 0.554 - ETA: 0s - loss: 7.0575 - acc: 0.556 - ETA: 0s - loss: 7.0774 - acc: 0.554 - ETA: 0s - loss: 7.0992 - acc: 0.553 - ETA: 0s - loss: 7.0887 - acc: 0.554 - ETA: 0s - loss: 7.1069 - acc: 0.553 - ETA: 0s - loss: 7.1419 - acc: 0.551 - ETA: 0s - loss: 7.1482 - acc: 0.550 - ETA: 0s - loss: 7.1685 - acc: 0.549 - ETA: 0s - loss: 7.1769 - acc: 0.549 - ETA: 0s - loss: 7.1849 - acc: 0.548 - ETA: 0s - loss: 7.1845 - acc: 0.548 - ETA: 0s - loss: 7.1792 - acc: 0.548 - ETA: 0s - loss: 7.1649 - acc: 0.5497Epoch 00019: val_loss did not improve 6680/6680 [=====] - 2s - loss: 7.1655 - acc: 0.5497 - val_loss: 7.8597 - val_acc: 0.4491

```
<keras.callbacks.History at 0x20136015be0>
```

Load the Model with the Best Validation Loss

```
VGG16_model.load_weights('saved_models/weights.best.VGG16.hdf5')
```

Test the Model

Now, we can use the CNN to test how well it identifies breed within our test dataset of dog images. We print the test accuracy below.

```
# get index of predicted dog breed for each image in test set
VGG16_predictions = [np.argmax(VGG16_model.predict(np.expand_dims(feature, axis=0))) for feature in test_VGG16]

# report test accuracy
test_accuracy = 100*np.sum(np.array(VGG16_predictions)==np.argmax(test_targets, axis=1))/len(VGG16_predictions)
print('Test accuracy: %.4f%%' % test_accuracy)
```

```
Test accuracy: 44.7368%
```

Predict Dog Breed with the Model

```
from extract_bottleneck_features import *

def VGG16_predict_breed(img_path):
    # extract bottleneck features
    bottleneck_feature = extract_VGG16(path_to_tensor(img_path))
    # obtain predicted vector
    predicted_vector = VGG16_model.predict(bottleneck_feature)
    # return dog breed that is predicted by the model
    return dog_names[np.argmax(predicted_vector)]
```

Step 5: Create a CNN to Classify Dog Breeds (using Transfer Learning)

You will now use transfer learning to create a CNN that can identify dog breed from images. Your CNN must attain at least 60% accuracy on the test set.

In Step 4, we used transfer learning to create a CNN using VGG-16 bottleneck features. In this section, you must use the bottleneck features from a different pre-trained model. To make things easier for you, we have pre-computed the

features for all of the networks that are currently available in Keras:

- [VGG-19](#) bottleneck features
- [ResNet-50](#) bottleneck features
- [Inception](#) bottleneck features
- [Xception](#) bottleneck features

The files are encoded as such:

```
Dog{network}Data.npz
```

where `{network}`, in the above filename, can be one of [VGG19](#), [Resnet50](#), [InceptionV3](#), or [Xception](#). Pick one of the above architectures, download the corresponding bottleneck features, and store the downloaded file in the [bottleneck_features/](#) folder in the repository.

(IMPLEMENTATION) Obtain Bottleneck Features

In the code block below, extract the bottleneck features corresponding to the train, test, and validation sets by running the following:

```
bottleneck_features = np.load('bottleneck_features/Dog{network}Data.npz')
train_{network} = bottleneck_features['train']
valid_{network} = bottleneck_features['valid']
test_{network} = bottleneck_features['test']
```

```
### TODO: Obtain bottleneck features from another pre-trained CNN.

#I have chosen Resnet50
bottleneck_features = np.load('bottleneck_features/DogResnet50Data.npz')
train_Resnet50 = bottleneck_features['train']
valid_Resnet50 = bottleneck_features['valid']
test_Resnet50 = bottleneck_features['test']
```

(IMPLEMENTATION) Model Architecture

Create a CNN to classify dog breed. At the end of your code cell block, summarize the layers of your model by executing the line:

```
model_ResNet50.summary()
```

Question 5: Outline the steps you took to get to your final CNN architecture and your reasoning at each step. Describe why you think the architecture is suitable for the current problem.

Answer:

- ResNet50 is fast, easy, small download, good results

- the default architecture model returns top results out of the box
- using GlobalAveragePooling2D as GAP
- dense with softmax activation function

```
### TODO: Define your architecture.

from keras.layers import GlobalAveragePooling2D
from keras.layers import Dense

model_ResNet50 = Sequential()

model_ResNet50.add(GlobalAveragePooling2D(input_shape=train_Resnet50.shape[1:]))
model_ResNet50.add(Dense(133, activation='softmax'))

model_ResNet50.summary()
```

Layer (type)	Output Shape	Param #
=====		
global_average_pooling2d_5 ((None, 2048)		0
=====		
dense_5 (Dense)	(None, 133)	272517
=====		
Total params: 272,517		
Trainable params: 272,517		
Non-trainable params: 0		
=====		

(IMPLEMENTATION) Compile the Model

```
### TODO: Compile the model.
model_ResNet50.compile(loss='categorical_crossentropy', optimizer='rmsprop', metrics=['accuracy'])
```

(IMPLEMENTATION) Train the Model

Train your model in the code cell below. Use model checkpointing to save the model that attains the best validation loss.

You are welcome to [augment the training data](#), but this is not a requirement.

```
### TODO: Train the model.

from keras.callbacks import ModelCheckpoint
```

```
# setup for image augmentation, with random 10% width and height and flip is aktiv

# impl. checkpoint
checkpointer = ModelCheckpoint(filepath='saved_models/weights.best.ResNet50.hdf5',
                                verbose=1, save_best_only=True)

epochs = 64
batch_size = 64

# default fit without augment training data
model_ResNet50.fit(train_Resnet50, train_targets,
                   validation_data=(valid_Resnet50, valid_targets),
                   epochs=epochs, batch_size=batch_size, callbacks=[checkpointer], verbose=1)
```

Train on 6680 samples, validate on 835 samples

Epoch 1/64

```
6592/6680 [=====>.] - ETA: 1s - loss: 6.0164e-07 - acc: 1.000 - ETA: 1s - loss: 9.9918e-07 - acc: 1.000 - ETA: 0s - loss: 3.3185e-06 - acc: 1.000 - ETA: 0s - loss: 2.7156e-06 - acc: 1.000 - ETA: 0s - loss: 0.0025 - acc: 0.9986 - ETA: 0s - loss: 0.0020 - acc: 0.998 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0015 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0015 - acc: 0.999 - ETA: 0s - loss: 0.0014 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9988Epoch 00000: val_loss improved from inf to 1.16908, saving model to saved_models/weights.best.ResNet50.hdf5
```

```
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9988 - val_loss: 1.1691 - val_acc: 0.8299
```

Epoch 2/64

```
6336/6680 [=====>..] - ETA: 1s - loss: 1.1921e-07 - acc: 1.000 - ETA: 0s - loss: 0.0018 - acc: 0.9978 - ETA: 0s - loss: 0.0027 - acc: 0.997 - ETA: 0s - loss: 0.0021 - acc: 0.998 - ETA: 0s - loss: 0.0016 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0036 - acc: 0.998 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0055 - acc: 0.998 - ETA: 0s - loss: 0.0051 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.9987Epoch 00001: val_loss improved from 1.16908 to 1.16238, saving model to saved_models/weights.best.ResNet50.hdf5
```

```
6680/6680 [=====] - 1s - loss: 0.0040 - acc: 0.9988 - val_loss: 1.1624 - val_acc: 0.8371
```

Epoch 3/64

```
6528/6680 [=====>.] - ETA: 1s - loss: 1.3504e-07 - acc: 1.000 - ETA: 1s - loss: 1.1226e-06 - acc: 1.000 - ETA: 0s - loss: 1.6942e-06 - acc: 1.000 - ETA: 0s - loss: 1.4417e-06 - acc: 1.000 - ETA: 0s - loss: 9.2916e-04 - acc: 0.999 - ETA: 0s - loss: 7.3722e-04 - acc: 0.999 - ETA: 0s - loss: 8.6184e-04 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.9992 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9986Epoch 00002: val_loss did not improve
```

```
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9987 - val_loss: 1.1631 - val_acc: 0.8311
```

Epoch 4/64

```
6464/6680 [=====>.] - ETA: 1s - loss: 1.5553e-07 - acc: 1.000 - ETA: 0s - loss: 0.0024 - acc: 0.9978 - ETA: 0s - loss: 0.0013 - acc: 0.998 - ETA: 0s - loss: 0.0014 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0059 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0033 - acc: 0.998 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0054 - acc: 0.998 - ETA: 0s - loss: 0.0058 - acc: 0.998 - ETA: 0s - loss: 0.0055 - acc: 0.998 - ETA: 0s - loss: 0.0051 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.9988Epoch 00003: val_loss did not improve
```

```
6680/6680 [=====] - 1s - loss: 0.0047 - acc: 0.9988 - val_loss: 1.1681 - val_acc: 0.8371
```

Epoch 5/64

```
6528/6680 [=====>.] - ETA: 1s - loss: 1.4017e-06 - acc: 1.000 - ETA: 0s - loss: 7.8631e-07 - acc: 1.000 - ETA: 0s - loss: 7.0724e-07 - acc: 1.000 - ETA: 0s - loss: 6.8801e-07 - acc: 1.000 - ETA: 0s - loss: 6.2364e-07 - acc: 1.000 - ETA: 0s - loss: 5.9594e-04 - acc: 0.999 - ETA: 0s - loss: 5.1177e-04 - acc: 0.999 - ETA: 0s - loss: 4.3538e-04 - acc: 0.999 - ETA: 0s - loss: 3.8716e-04 - acc: 0.999 - ETA: 0s - loss: 3.4172e-04 - acc: 0.999 - ETA: 0s - loss: 7.0161e-04 - acc: 0.999 - ETA: 0s - loss: 7.3988e-04 - acc: 0.999 - ETA: 0s - loss: 6.7521e-04 - acc: 0.999 - ETA: 0s - loss: 7.5901e-04 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.9992 - ETA: 0s - loss: 0.0035 - acc: 0.999 -
```

ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.9989Epoch 00004: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9990 - val_loss: 1.1714 - val_acc: 0.8359
Epoch 6/64
6528/6680 [=====>.] - ETA: 1s - loss: 1.3597e-07 - acc: 1.000 - ETA: 0s - loss: 6.1003e-07 - acc: 1.000 - ETA: 0s - loss: 1.0073e-06 - acc: 1.000 - ETA: 0s - loss: 6.2247e-04 - acc: 1.000 - ETA: 0s - loss: 9.5597e-04 - acc: 1.000 - ETA: 0s - loss: 7.7522e-04 - acc: 1.000 - ETA: 0s - loss: 0.0031 - acc: 0.9995 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0037 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.999 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.9992Epoch 00005: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9991 - val_loss: 1.1744 - val_acc: 0.8311
Epoch 7/64
6336/6680 [=====>..] - ETA: 1s - loss: 1.2713e-06 - acc: 1.000 - ETA: 1s - loss: 6.9120e-07 - acc: 1.000 - ETA: 1s - loss: 6.0283e-07 - acc: 1.000 - ETA: 0s - loss: 0.0015 - acc: 0.9980 - ETA: 0s - loss: 0.0014 - acc: 0.998 - ETA: 0s - loss: 0.0011 - acc: 0.998 - ETA: 0s - loss: 0.0014 - acc: 0.998 - ETA: 0s - loss: 0.0015 - acc: 0.998 - ETA: 0s - loss: 0.0029 - acc: 0.998 - ETA: 0s - loss: 0.0026 - acc: 0.998 - ETA: 0s - loss: 0.0024 - acc: 0.998 - ETA: 0s - loss: 0.0022 - acc: 0.998 - ETA: 0s - loss: 0.0020 - acc: 0.998 - ETA: 0s - loss: 0.0018 - acc: 0.998 - ETA: 0s - loss: 0.0027 - acc: 0.998 - ETA: 0s - loss: 0.0025 - acc: 0.998 - ETA: 0s - loss: 0.0033 - acc: 0.998 - ETA: 0s - loss: 0.0031 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.9986Epoch 00006: val_loss improved from 1.16238 to 1.15793, saving model to saved_models/weights.best.ResNet50.hdf5
6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9987 - val_loss: 1.1579 - val_acc: 0.8347
Epoch 8/64
6592/6680 [=====>.] - ETA: 1s - loss: 8.2432e-06 - acc: 1.000 - ETA: 0s - loss: 0.0013 - acc: 1.0000 - ETA: 0s - loss: 0.0076 - acc: 0.998 - ETA: 0s - loss: 0.0054 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0072 - acc: 0.998 - ETA: 0s - loss: 0.0064 - acc: 0.998 - ETA: 0s - loss: 0.0058 - acc: 0.998 - ETA: 0s - loss: 0.0053 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.999 - ETA: 0s - loss: 0.0051 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.9991Epoch 00007: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9991 - val_loss: 1.1733 - val_acc: 0.8383
Epoch 9/64
6336/6680 [=====>..] - ETA: 1s - loss: 1.8339e-06 - acc: 1.000 - ETA: 0s - loss: 9.8936e-07 - acc: 1.000 - ETA: 0s - loss: 8.1135e-07 - acc: 1.000 - ETA: 0s - loss: 6.9442e-07 - acc: 1.000 - ETA: 0s - loss: 8.8334e-04 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.9990 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0021 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0054 - acc: 0.998 - ETA: 0s - loss: 0.0051 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.9986Epoch 00008: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0046 - acc: 0.9987 - val_loss: 1.1771 - val_acc: 0.8323
Epoch 10/64
6336/6680 [=====>..] - ETA: 1s - loss: 0.0099 - acc: 1.000 - ETA: 0s - loss: 0.0014 - acc: 1.000 - ETA: 0s - loss: 7.6057e-04 - acc: 1.000 - ETA: 0s - loss: 8.8562e-04 - acc: 1.000 - ETA: 0s - loss: 0.0014 - acc: 1.0000 - ETA: 0s - loss: 0.0015 - acc: 1.000 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0049 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.9992Epoch 00009: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9993 - val_loss: 1.1805 - val_acc: 0.8287
Epoch 11/64
6656/6680 [=====>.] - ETA: 0s - loss: 2.0396e-07 - acc: 1.000 - ETA: 0s - loss: 8.7136e-07 - acc: 1.000 - ETA: 0s - loss: 0.0020 - acc: 0.9987 - ETA: 0s - loss: 0.0013 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0013 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.9991Epoch 00010: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9991 - val_loss: 1.1752 - val_acc: 0.8287
Epoch 12/64
6464/6680 [=====>.] - ETA: 1s - loss: 1.3784e-07 - acc: 1.000 - ETA: 0s - loss: 0.0020 - acc: 0.9978 - ETA: 0s - loss: 0.0012 - acc: 0.998 - ETA: 0s - loss: 0.0018 - acc: 0.998 - ETA: 0s - loss: 0.0013 - acc: 0.998 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 9.2199e-04 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.9989 - ETA: 0s - loss: 0.0036 - acc: 0.998 - ETA: 0s - loss: 0.0055 - acc: 0.997 - ETA: 0s - loss: 0.0062 - acc: 0.997 - ETA: 0s - loss: 0.0064 - acc: 0.997 - ETA: 0s - loss: 0.0060 - acc: 0.998 - ETA: 0s - loss: 0.0056 - acc: 0.998 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.9986Epoch 00011: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0040 - acc: 0.9987 - val_loss: 1.1759 - val_acc: 0.8347

Epoch 13/64
6400/6680 [=====>..] - ETA: 1s - loss: 1.2107e-07 - acc: 1.000 - ETA: 0s - loss: 0.0022 - acc: 0.9978 - ETA: 0s - loss: 0.0012 - acc: 0.998 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0049 - acc: 0.999 - ETA: 0s - loss: 0.0055 - acc: 0.998 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.9991Epoch 00012: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9991 - val_loss: 1.1742 - val_acc: 0.8335
Epoch 14/64
6592/6680 [=====>.] - ETA: 1s - loss: 8.5870e-07 - acc: 1.000 - ETA: 0s - loss: 7.4308e-04 - acc: 1.000 - ETA: 0s - loss: 0.0036 - acc: 0.9964 - ETA: 0s - loss: 0.0024 - acc: 0.997 - ETA: 0s - loss: 0.0026 - acc: 0.997 - ETA: 0s - loss: 0.0021 - acc: 0.998 - ETA: 0s - loss: 0.0017 - acc: 0.998 - ETA: 0s - loss: 0.0031 - acc: 0.998 - ETA: 0s - loss: 0.0030 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.9986Epoch 00013: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9987 - val_loss: 1.1755 - val_acc: 0.8335
Epoch 15/64
6400/6680 [=====>..] - ETA: 1s - loss: 1.5832e-07 - acc: 1.000 - ETA: 0s - loss: 2.5907e-06 - acc: 1.000 - ETA: 0s - loss: 1.9573e-06 - acc: 1.000 - ETA: 0s - loss: 1.5849e-06 - acc: 1.000 - ETA: 0s - loss: 1.4846e-06 - acc: 1.000 - ETA: 0s - loss: 1.2466e-06 - acc: 1.000 - ETA: 0s - loss: 6.3882e-04 - acc: 0.999 - ETA: 0s - loss: 6.1693e-04 - acc: 0.999 - ETA: 0s - loss: 0.0010 - acc: 0.9993 - ETA: 0s - loss: 9.1679e-04 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.9989 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.9989Epoch 00014: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9988 - val_loss: 1.1878 - val_acc: 0.8311
Epoch 16/64
6656/6680 [=====>.] - ETA: 1s - loss: 1.3318e-07 - acc: 1.000 - ETA: 1s - loss: 5.0044e-07 - acc: 1.000 - ETA: 0s - loss: 8.9039e-07 - acc: 1.000 - ETA: 0s - loss: 2.5785e-06 - acc: 1.000 - ETA: 0s - loss: 5.9782e-04 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.9988 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9988Epoch 00015: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9988 - val_loss: 1.1831 - val_acc: 0.8311
Epoch 17/64
6656/6680 [=====>.] - ETA: 1s - loss: 2.7381e-07 - acc: 1.000 - ETA: 0s - loss: 4.0233e-07 - acc: 1.000 - ETA: 0s - loss: 4.6452e-07 - acc: 1.000 - ETA: 0s - loss: 5.4704e-07 - acc: 1.000 - ETA: 0s - loss: 4.6966e-04 - acc: 0.999 - ETA: 0s - loss: 7.7246e-04 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.9987 - ETA: 0s - loss: 9.8416e-04 - acc: 0.998 - ETA: 0s - loss: 9.4985e-04 - acc: 0.999 - ETA: 0s - loss: 8.4446e-04 - acc: 0.999 - ETA: 0s - loss: 0.0014 - acc: 0.9987 - ETA: 0s - loss: 0.0033 - acc: 0.998 - ETA: 0s - loss: 0.0031 - acc: 0.998 - ETA: 0s - loss: 0.0028 - acc: 0.998 - ETA: 0s - loss: 0.0026 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.9985Epoch 00016: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9985 - val_loss: 1.1888 - val_acc: 0.8335
Epoch 18/64
6592/6680 [=====>.] - ETA: 1s - loss: 2.2529e-06 - acc: 1.000 - ETA: 0s - loss: 4.6780e-07 - acc: 1.000 - ETA: 0s - loss: 6.2478e-07 - acc: 1.000 - ETA: 0s - loss: 6.3875e-07 - acc: 1.000 - ETA: 0s - loss: 5.0351e-04 - acc: 0.999 - ETA: 0s - loss: 8.9389e-04 - acc: 0.999 - ETA: 0s - loss: 7.4500e-04 - acc: 0.999 - ETA: 0s - loss: 6.3862e-04 - acc: 0.999 - ETA: 0s - loss: 5.5888e-04 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.9991 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0015 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9986Epoch 00017: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9987 - val_loss: 1.1846 - val_acc: 0.8335
Epoch 19/64
6656/6680 [=====>.] - ETA: 1s - loss: 0.0148 - acc: 0.984 - ETA: 0s - loss: 0.0021 - acc: 0.997 - ETA: 0s - loss: 0.0011 - acc: 0.998 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 8.9565e-04 - acc: 0.999 - ETA: 0s - loss: 7.2241e-04 - acc: 0.999 - ETA: 0s - loss: 6.0669e-04 - acc: 0.999 - ETA: 0s - loss: 5.2223e-04 - acc: 0.999 - ETA: 0s - loss: 4.5834e-04 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.9988 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9989Epoch 00018: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9990 - val_loss: 1.1786 - val_acc: 0.8311
Epoch 20/64
6528/6680 [=====>.] - ETA: 1s - loss: 8.7638e-07 - acc: 1.000 - ETA: 1s - loss: 4.1243e-04 - acc: 1.000 - ETA: 0s - loss: 2.2527e-04 - acc: 1.000 - ETA: 0s

- loss: 1.5502e-04 - acc: 1.000 - ETA: 0s - loss: 1.1840e-04 - acc: 1.000 - ETA: 0s - loss: 9.2214e-05 - acc: 1.000 - ETA: 0s - loss: 8.1494e-04 - acc: 1.000 - ETA: 0s - loss: 6.8988e-04 - acc: 1.000 - ETA: 0s - loss: 6.1172e-04 - acc: 1.000 - ETA: 0s - loss: 7.0522e-04 - acc: 1.000 - ETA: 0s - loss: 6.4032e-04 - acc: 1.000 - ETA: 0s - loss: 5.8625e-04 - acc: 1.000 - ETA: 0s - loss: 7.3195e-04 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.9993 - ETA: 0s - loss: 0.0042 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.9991Epoch 00019: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9991 - val_loss: 1.1720 - val_acc: 0.8347
Epoch 21/64
6464/6680 [=====>.] - ETA: 1s - loss: 0.0126 - acc: 0.984 - ETA: 1s - loss: 0.0021 - acc: 0.997 - ETA: 0s - loss: 0.0024 - acc: 0.998 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0065 - acc: 0.998 - ETA: 0s - loss: 0.0057 - acc: 0.998 - ETA: 0s - loss: 0.0059 - acc: 0.998 - ETA: 0s - loss: 0.0061 - acc: 0.998 - ETA: 0s - loss: 0.0055 - acc: 0.998 - ETA: 0s - loss: 0.0061 - acc: 0.998 - ETA: 0s - loss: 0.0057 - acc: 0.998 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.9991Epoch 00020: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0039 - acc: 0.9991 - val_loss: 1.1757 - val_acc: 0.8323
Epoch 22/64
6400/6680 [=====>..] - ETA: 0s - loss: 5.7556e-07 - acc: 1.000 - ETA: 0s - loss: 2.6413e-04 - acc: 1.000 - ETA: 0s - loss: 1.5932e-04 - acc: 1.000 - ETA: 0s - loss: 8.8209e-04 - acc: 0.999 - ETA: 0s - loss: 6.6483e-04 - acc: 0.999 - ETA: 0s - loss: 5.3201e-04 - acc: 0.999 - ETA: 0s - loss: 4.5651e-04 - acc: 0.999 - ETA: 0s - loss: 3.9955e-04 - acc: 0.999 - ETA: 0s - loss: 3.5543e-04 - acc: 0.999 - ETA: 0s - loss: 5.1100e-04 - acc: 0.999 - ETA: 0s - loss: 4.6581e-04 - acc: 0.999 - ETA: 0s - loss: 4.2797e-04 - acc: 0.999 - ETA: 0s - loss: 7.5582e-04 - acc: 0.999 - ETA: 0s - loss: 6.9318e-04 - acc: 0.999 - ETA: 0s - loss: 0.0016 - acc: 0.9994 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.9989Epoch 00021: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9990 - val_loss: 1.1881 - val_acc: 0.8311
Epoch 23/64
6400/6680 [=====>..] - ETA: 1s - loss: 1.4715e-07 - acc: 1.000 - ETA: 0s - loss: 3.0093e-06 - acc: 1.000 - ETA: 0s - loss: 8.0909e-04 - acc: 1.000 - ETA: 0s - loss: 5.5409e-04 - acc: 1.000 - ETA: 0s - loss: 0.0041 - acc: 0.9987 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.9992Epoch 00022: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9991 - val_loss: 1.1895 - val_acc: 0.8275
Epoch 24/64
6336/6680 [=====>..] - ETA: 1s - loss: 7.4520e-06 - acc: 1.000 - ETA: 0s - loss: 2.8223e-06 - acc: 1.000 - ETA: 0s - loss: 5.9547e-04 - acc: 1.000 - ETA: 0s - loss: 0.0018 - acc: 0.9984 - ETA: 0s - loss: 0.0014 - acc: 0.998 - ETA: 0s - loss: 0.0012 - acc: 0.998 - ETA: 0s - loss: 0.0023 - acc: 0.998 - ETA: 0s - loss: 0.0022 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0032 - acc: 0.998 - ETA: 0s - loss: 0.0029 - acc: 0.998 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9989Epoch 00023: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9990 - val_loss: 1.1848 - val_acc: 0.8299
Epoch 25/64
6592/6680 [=====>.] - ETA: 1s - loss: 2.7102e-07 - acc: 1.000 - ETA: 1s - loss: 0.0011 - acc: 1.0000 - ETA: 0s - loss: 0.0041 - acc: 0.997 - ETA: 0s - loss: 0.0028 - acc: 0.998 - ETA: 0s - loss: 0.0021 - acc: 0.998 - ETA: 0s - loss: 0.0064 - acc: 0.997 - ETA: 0s - loss: 0.0054 - acc: 0.997 - ETA: 0s - loss: 0.0050 - acc: 0.997 - ETA: 0s - loss: 0.0044 - acc: 0.997 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0036 - acc: 0.998 - ETA: 0s - loss: 0.0033 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0051 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.9985Epoch 00024: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9985 - val_loss: 1.1902 - val_acc: 0.8347
Epoch 26/64
6656/6680 [=====>.] - ETA: 1s - loss: 1.2107e-07 - acc: 1.000 - ETA: 0s - loss: 0.0019 - acc: 0.9978 - ETA: 0s - loss: 0.0011 - acc: 0.998 - ETA: 0s - loss: 0.0025 - acc: 0.998 - ETA: 0s - loss: 0.0023 - acc: 0.998 - ETA: 0s - loss: 0.0019 - acc: 0.998 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0014 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 9.7527e-04 - acc: 0.999 - ETA: 0s - loss: 8.9276e-04 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.9993 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.9989Epoch 00025: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9990 - val_loss: 1.1864 - val_acc: 0.8323
Epoch 27/64
6464/6680 [=====>.] - ETA: 1s - loss: 1.2293e-07 - acc: 1.000 - ETA: 1s - loss: 3.6974e-07 - acc: 1.000 - ETA: 0s - loss: 2.9650e-06 - acc: 1.000 - ETA: 0s - loss: 2.1195e-06 - acc: 1.000 - ETA: 0s - loss: 3.1119e-04 - acc: 1.000 - ETA: 0s - loss: 5.1758e-04 - acc: 1.000 - ETA: 0s - loss: 4.2769e-04 - acc: 1.000 - ETA: 0s - loss:

4.0310e-04 - acc: 1.000 - ETA: 0s - loss: 0.0027 - acc: 0.9997 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0021 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.9991Epoch 00026: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0038 - acc: 0.9991 - val_loss: 1.1822 - val_acc: 0.8335
Epoch 28/64
6464/6680 [=====>.] - ETA: 1s - loss: 9.7604e-07 - acc: 1.000 - ETA: 1s - loss: 0.0075 - acc: 0.9974 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.998 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.999 - ETA: 0s - loss: 0.0049 - acc: 0.998 - ETA: 0s - loss: 0.0054 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9988Epoch 00027: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9988 - val_loss: 1.1814 - val_acc: 0.8311
Epoch 29/64
6656/6680 [=====>.] - ETA: 1s - loss: 3.3714e-07 - acc: 1.000 - ETA: 0s - loss: 2.0815e-07 - acc: 1.000 - ETA: 0s - loss: 2.6611e-07 - acc: 1.000 - ETA: 0s - loss: 3.8672e-07 - acc: 1.000 - ETA: 0s - loss: 5.5100e-07 - acc: 1.000 - ETA: 0s - loss: 7.0179e-04 - acc: 0.999 - ETA: 0s - loss: 5.9921e-04 - acc: 0.999 - ETA: 0s - loss: 5.2250e-04 - acc: 0.999 - ETA: 0s - loss: 4.6562e-04 - acc: 0.999 - ETA: 0s - loss: 4.1834e-04 - acc: 0.999 - ETA: 0s - loss: 3.7980e-04 - acc: 0.999 - ETA: 0s - loss: 3.4782e-04 - acc: 0.999 - ETA: 0s - loss: 3.2073e-04 - acc: 0.999 - ETA: 0s - loss: 4.9466e-04 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.9994 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9986Epoch 00028: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9987 - val_loss: 1.1782 - val_acc: 0.8371
Epoch 30/64
6464/6680 [=====>.] - ETA: 1s - loss: 1.4091e-06 - acc: 1.000 - ETA: 1s - loss: 2.7746e-04 - acc: 1.000 - ETA: 0s - loss: 8.7517e-04 - acc: 1.000 - ETA: 0s - loss: 6.1801e-04 - acc: 1.000 - ETA: 0s - loss: 4.7780e-04 - acc: 1.000 - ETA: 0s - loss: 3.8963e-04 - acc: 1.000 - ETA: 0s - loss: 3.1892e-04 - acc: 1.000 - ETA: 0s - loss: 2.6998e-04 - acc: 1.000 - ETA: 0s - loss: 4.9136e-04 - acc: 0.999 - ETA: 0s - loss: 6.9396e-04 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.9992 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.9991Epoch 00029: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9990 - val_loss: 1.1765 - val_acc: 0.8275
Epoch 31/64
6464/6680 [=====>.] - ETA: 1s - loss: 0.0122 - acc: 0.984 - ETA: 0s - loss: 0.0017 - acc: 0.997 - ETA: 0s - loss: 9.4038e-04 - acc: 0.998 - ETA: 0s - loss: 6.4464e-04 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.9988 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0051 - acc: 0.998 - ETA: 0s - loss: 0.0054 - acc: 0.998 - ETA: 0s - loss: 0.0051 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.9988Epoch 00030: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9988 - val_loss: 1.1764 - val_acc: 0.8311
Epoch 32/64
6592/6680 [=====>.] - ETA: 1s - loss: 1.2852e-07 - acc: 1.000 - ETA: 0s - loss: 8.0045e-07 - acc: 1.000 - ETA: 0s - loss: 0.0028 - acc: 0.9988 - ETA: 0s - loss: 0.0064 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.9991Epoch 00031: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9991 - val_loss: 1.1746 - val_acc: 0.8311
Epoch 33/64
6400/6680 [=====>..] - ETA: 1s - loss: 1.5926e-07 - acc: 1.000 - ETA: 1s - loss: 1.6190e-07 - acc: 1.000 - ETA: 0s - loss: 7.9435e-07 - acc: 1.000 - ETA: 0s - loss: 1.0942e-06 - acc: 1.000 - ETA: 0s - loss: 9.1647e-07 - acc: 1.000 - ETA: 0s - loss: 8.8018e-07 - acc: 1.000 - ETA: 0s - loss: 0.0026 - acc: 0.9990 - ETA: 0s - loss: 0.0029 - acc: 0.998 - ETA: 0s - loss: 0.0025 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0037 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.9989Epoch 00032: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9990 - val_loss: 1.1783 - val_acc: 0.8323
Epoch 34/64
6464/6680 [=====>.] - ETA: 1s - loss: 2.1700e-07 - acc: 1.000 - ETA: 0s - loss: 7.4388e-07 - acc: 1.000 - ETA: 0s - loss: 6.6248e-07 - acc: 1.000 - ETA: 0s - loss: 7.9937e-07 - acc: 1.000 - ETA: 0s - loss: 6.5260e-04 - acc: 1.000 - ETA: 0s - loss: 7.1192e-04 - acc: 1.000 - ETA: 0s - loss: 5.9715e-04 - acc: 1.000 - ETA: 0s - loss: 5.1390e-04 - acc: 1.000 - ETA: 0s - loss: 8.7165e-04 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.9994 - ETA: 0s - loss: 0.0020 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0056 - acc: 0.998 - ETA: 0s - loss: 0.0051 - acc: 0.999 - ETA: 0s - loss: 0.0048 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.999 - ETA: 0s - loss:

0.0042 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.9991Epoch 00033: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0045 - acc: 0.9991 - val_loss: 1.1784 - val_acc: 0.8359
Epoch 35/64
6592/6680 [=====>.] - ETA: 1s - loss: 1.1921e-07 - acc: 1.000 - ETA: 0s - loss: 2.1966e-07 - acc: 1.000 - ETA: 0s - loss: 0.0025 - acc: 0.9988 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.998 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.999 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.9991Epoch 00034: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9991 - val_loss: 1.1873 - val_acc: 0.8347
Epoch 36/64
6592/6680 [=====>.] - ETA: 1s - loss: 2.5705e-07 - acc: 1.000 - ETA: 0s - loss: 8.2508e-07 - acc: 1.000 - ETA: 0s - loss: 7.5434e-07 - acc: 1.000 - ETA: 0s - loss: 0.0091 - acc: 0.9975 - ETA: 0s - loss: 0.0069 - acc: 0.998 - ETA: 0s - loss: 0.0056 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.9989Epoch 00035: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0045 - acc: 0.9990 - val_loss: 1.1816 - val_acc: 0.8359
Epoch 37/64
6464/6680 [=====>.] - ETA: 1s - loss: 3.3528e-07 - acc: 1.000 - ETA: 0s - loss: 3.6335e-07 - acc: 1.000 - ETA: 0s - loss: 0.0027 - acc: 0.9976 - ETA: 0s - loss: 0.0019 - acc: 0.998 - ETA: 0s - loss: 0.0014 - acc: 0.998 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0031 - acc: 0.998 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.998 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0020 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.998 - ETA: 0s - loss: 0.0029 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0049 - acc: 0.9985Epoch 00036: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0047 - acc: 0.9985 - val_loss: 1.1907 - val_acc: 0.8347
Epoch 38/64
6592/6680 [=====>.] - ETA: 1s - loss: 1.8711e-06 - acc: 1.000 - ETA: 0s - loss: 6.7483e-07 - acc: 1.000 - ETA: 0s - loss: 0.0022 - acc: 0.9976 - ETA: 0s - loss: 0.0015 - acc: 0.998 - ETA: 0s - loss: 0.0011 - acc: 0.998 - ETA: 0s - loss: 9.2704e-04 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.9987 - ETA: 0s - loss: 0.0026 - acc: 0.998 - ETA: 0s - loss: 0.0023 - acc: 0.998 - ETA: 0s - loss: 0.0021 - acc: 0.998 - ETA: 0s - loss: 0.0022 - acc: 0.998 - ETA: 0s - loss: 0.0020 - acc: 0.998 - ETA: 0s - loss: 0.0018 - acc: 0.998 - ETA: 0s - loss: 0.0020 - acc: 0.998 - ETA: 0s - loss: 0.0025 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.9985Epoch 00037: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0040 - acc: 0.9985 - val_loss: 1.1838 - val_acc: 0.8311
Epoch 39/64
6336/6680 [=====>..] - ETA: 0s - loss: 4.1537e-07 - acc: 1.000 - ETA: 0s - loss: 9.6617e-04 - acc: 1.000 - ETA: 0s - loss: 5.6397e-04 - acc: 1.000 - ETA: 0s - loss: 3.7623e-04 - acc: 1.000 - ETA: 0s - loss: 6.6194e-04 - acc: 1.000 - ETA: 0s - loss: 7.9802e-04 - acc: 1.000 - ETA: 0s - loss: 0.0012 - acc: 0.9995 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0021 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.9992Epoch 00038: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9991 - val_loss: 1.1881 - val_acc: 0.8275
Epoch 40/64
6592/6680 [=====>.] - ETA: 1s - loss: 0.0211 - acc: 0.984 - ETA: 0s - loss: 0.0030 - acc: 0.997 - ETA: 0s - loss: 0.0016 - acc: 0.998 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 8.4443e-04 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.9990 - ETA: 0s - loss: 0.0013 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.9991Epoch 00039: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0039 - acc: 0.9990 - val_loss: 1.1689 - val_acc: 0.8323
Epoch 41/64
6464/6680 [=====>.] - ETA: 1s - loss: 2.8685e-07 - acc: 1.000 - ETA: 0s - loss: 2.2139e-07 - acc: 1.000 - ETA: 0s - loss: 1.3694e-05 - acc: 1.000 - ETA: 0s - loss: 1.0362e-05 - acc: 1.000 - ETA: 0s - loss: 8.1261e-06 - acc: 1.000 - ETA: 0s - loss: 6.8860e-06 - acc: 1.000 - ETA: 0s - loss: 5.9595e-06 - acc: 1.000 - ETA: 0s - loss: 8.6203e-06 - acc: 1.000 - ETA: 0s - loss: 7.9406e-06 - acc: 1.000 - ETA: 0s - loss: 7.0774e-06 - acc: 1.000 - ETA: 0s - loss: 0.0013 - acc: 0.9997 - ETA: 0s - loss: 0.0015 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9988Epoch 00040: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9988 - val_loss: 1.1888 - val_acc: 0.8383
Epoch 42/64

6528/6680 [=====>.] - ETA: 1s - loss: 1.6298e-07 - acc: 1.000 - ETA: 0s - loss: 0.0120 - acc: 0.9955 - ETA: 0s - loss: 0.0069 - acc: 0.997 - ETA: 0s - loss: 0.0056 - acc: 0.997 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0029 - acc: 0.998 - ETA: 0s - loss: 0.0028 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0032 - acc: 0.998 - ETA: 0s - loss: 0.0032 - acc: 0.998 - ETA: 0s - loss: 0.0029 - acc: 0.998 - ETA: 0s - loss: 0.0027 - acc: 0.998 - ETA: 0s - loss: 0.0025 - acc: 0.998 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.9986Epoch 00041: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0039 - acc: 0.9987 - val_loss: 1.2029 - val_acc: 0.8347
Epoch 43/64
6464/6680 [=====>.] - ETA: 1s - loss: 0.0243 - acc: 0.984 - ETA: 0s - loss: 0.0035 - acc: 0.997 - ETA: 0s - loss: 0.0022 - acc: 0.998 - ETA: 0s - loss: 0.0058 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0069 - acc: 0.998 - ETA: 0s - loss: 0.0077 - acc: 0.997 - ETA: 0s - loss: 0.0066 - acc: 0.998 - ETA: 0s - loss: 0.0058 - acc: 0.998 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9988Epoch 00042: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9988 - val_loss: 1.1857 - val_acc: 0.8323
Epoch 44/64
6592/6680 [=====>.] - ETA: 0s - loss: 1.6764e-07 - acc: 1.000 - ETA: 0s - loss: 4.2073e-04 - acc: 1.000 - ETA: 0s - loss: 2.2670e-04 - acc: 1.000 - ETA: 0s - loss: 1.5530e-04 - acc: 1.000 - ETA: 0s - loss: 1.1835e-04 - acc: 1.000 - ETA: 0s - loss: 4.6938e-04 - acc: 0.999 - ETA: 0s - loss: 3.9356e-04 - acc: 0.999 - ETA: 0s - loss: 6.0883e-04 - acc: 0.999 - ETA: 0s - loss: 5.3458e-04 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.9991 - ETA: 0s - loss: 0.0018 - acc: 0.999 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0042 - acc: 0.9989Epoch 00043: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9990 - val_loss: 1.1951 - val_acc: 0.8335
Epoch 45/64
6656/6680 [=====>.] - ETA: 1s - loss: 1.6205e-07 - acc: 1.000 - ETA: 0s - loss: 5.4493e-04 - acc: 1.000 - ETA: 0s - loss: 0.0074 - acc: 0.9974 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0046 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0034 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0036 - acc: 0.998 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.9989Epoch 00044: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0036 - acc: 0.9990 - val_loss: 1.2004 - val_acc: 0.8371
Epoch 46/64
6528/6680 [=====>.] - ETA: 1s - loss: 2.2166e-07 - acc: 1.000 - ETA: 0s - loss: 5.9180e-07 - acc: 1.000 - ETA: 0s - loss: 6.2522e-07 - acc: 1.000 - ETA: 0s - loss: 9.1897e-04 - acc: 0.999 - ETA: 0s - loss: 9.9026e-04 - acc: 0.999 - ETA: 0s - loss: 7.9930e-04 - acc: 0.999 - ETA: 0s - loss: 6.6990e-04 - acc: 0.999 - ETA: 0s - loss: 5.7652e-04 - acc: 0.999 - ETA: 0s - loss: 5.2617e-04 - acc: 0.999 - ETA: 0s - loss: 4.6863e-04 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.9995 - ETA: 0s - loss: 0.0037 - acc: 0.999 - ETA: 0s - loss: 0.0034 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0052 - acc: 0.999 - ETA: 0s - loss: 0.0049 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.9991Epoch 00045: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0045 - acc: 0.9991 - val_loss: 1.2019 - val_acc: 0.8299
Epoch 47/64
6592/6680 [=====>.] - ETA: 1s - loss: 1.2852e-07 - acc: 1.000 - ETA: 0s - loss: 8.6284e-07 - acc: 1.000 - ETA: 0s - loss: 6.3210e-07 - acc: 1.000 - ETA: 0s - loss: 4.1951e-04 - acc: 1.000 - ETA: 0s - loss: 9.0480e-04 - acc: 0.999 - ETA: 0s - loss: 0.0013 - acc: 0.9990 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 9.4640e-04 - acc: 0.999 - ETA: 0s - loss: 0.0048 - acc: 0.9984 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.9988Epoch 00046: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9988 - val_loss: 1.1993 - val_acc: 0.8287
Epoch 48/64
6528/6680 [=====>.] - ETA: 1s - loss: 3.4180e-07 - acc: 1.000 - ETA: 0s - loss: 7.5798e-07 - acc: 1.000 - ETA: 0s - loss: 6.2508e-07 - acc: 1.000 - ETA: 0s - loss: 4.9082e-07 - acc: 1.000 - ETA: 0s - loss: 6.0351e-04 - acc: 0.999 - ETA: 0s - loss: 5.5800e-04 - acc: 0.999 - ETA: 0s - loss: 4.6758e-04 - acc: 0.999 - ETA: 0s - loss: 6.0172e-04 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.9990 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.9991Epoch 00047: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9991 - val_loss: 1.1877 - val_acc: 0.8371
Epoch 49/64
6528/6680 [=====>.] - ETA: 1s - loss: 0.0146 - acc: 0.984 - ETA: 1s - loss: 0.0030 - acc: 0.997 - ETA: 0s - loss: 0.0015 - acc: 0.998 - ETA: 0s - loss: 0.0071 - acc: 0.998 - ETA: 0s - loss: 0.0053 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.999 - ETA: 0s - loss: 0.0079 - acc: 0.998 - ETA: 0s - loss: 0.0068 - acc: 0.998 - ETA: 0s - loss: 0.0059 - acc: 0.998 - ETA: 0s - loss: 0.0053 - acc: 0.998 - ETA: 0s - loss: 0.0062 - acc:

0.998 - ETA: 0s - loss: 0.0057 - acc: 0.998 - ETA: 0s - loss: 0.0053 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.9991Epoch 00048: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9991 - val_loss: 1.1910 - val_acc: 0.8299
Epoch 50/64
6592/6680 [=====>.] - ETA: 1s - loss: 3.4180e-07 - acc: 1.000 - ETA: 0s - loss: 0.0052 - acc: 0.9955 - ETA: 0s - loss: 0.0028 - acc: 0.997 - ETA: 0s - loss: 0.0019 - acc: 0.998 - ETA: 0s - loss: 0.0017 - acc: 0.998 - ETA: 0s - loss: 0.0014 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0031 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9986Epoch 00049: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9987 - val_loss: 1.1979 - val_acc: 0.8263
Epoch 51/64
6592/6680 [=====>.] - ETA: 0s - loss: 2.6356e-07 - acc: 1.000 - ETA: 0s - loss: 2.1234e-07 - acc: 1.000 - ETA: 0s - loss: 0.0011 - acc: 1.0000 - ETA: 0s - loss: 0.0054 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0048 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0037 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.999 - ETA: 0s - loss: 0.0050 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.9991Epoch 00050: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9991 - val_loss: 1.1932 - val_acc: 0.8335
Epoch 52/64
6400/6680 [=====>..] - ETA: 1s - loss: 0.0116 - acc: 0.984 - ETA: 0s - loss: 0.0017 - acc: 0.997 - ETA: 0s - loss: 8.9365e-04 - acc: 0.998 - ETA: 0s - loss: 0.0107 - acc: 0.9967 - ETA: 0s - loss: 0.0081 - acc: 0.997 - ETA: 0s - loss: 0.0065 - acc: 0.998 - ETA: 0s - loss: 0.0055 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0036 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.998 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0035 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.9986Epoch 00051: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9987 - val_loss: 1.1867 - val_acc: 0.8359
Epoch 53/64
6464/6680 [=====>.] - ETA: 1s - loss: 1.5832e-07 - acc: 1.000 - ETA: 0s - loss: 6.1961e-04 - acc: 1.000 - ETA: 0s - loss: 0.0012 - acc: 0.9988 - ETA: 0s - loss: 8.0999e-04 - acc: 0.999 - ETA: 0s - loss: 6.1575e-04 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.9985 - ETA: 0s - loss: 0.0038 - acc: 0.998 - ETA: 0s - loss: 0.0057 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0065 - acc: 0.998 - ETA: 0s - loss: 0.0059 - acc: 0.998 - ETA: 0s - loss: 0.0054 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.998 - ETA: 0s - loss: 0.0044 - acc: 0.9988Epoch 00052: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9988 - val_loss: 1.1850 - val_acc: 0.8371
Epoch 54/64
6528/6680 [=====>.] - ETA: 1s - loss: 2.7567e-07 - acc: 1.000 - ETA: 1s - loss: 4.1972e-07 - acc: 1.000 - ETA: 0s - loss: 0.0018 - acc: 0.9986 - ETA: 0s - loss: 0.0012 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 8.8397e-04 - acc: 0.999 - ETA: 0s - loss: 7.4598e-04 - acc: 0.999 - ETA: 0s - loss: 6.4523e-04 - acc: 0.999 - ETA: 0s - loss: 0.0010 - acc: 0.9993 - ETA: 0s - loss: 9.5007e-04 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.9991 - ETA: 0s - loss: 0.0034 - acc: 0.998 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0031 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.9989Epoch 00053: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9990 - val_loss: 1.1902 - val_acc: 0.8311
Epoch 55/64
6400/6680 [=====>..] - ETA: 0s - loss: 1.5367e-07 - acc: 1.000 - ETA: 0s - loss: 0.0024 - acc: 0.9978 - ETA: 0s - loss: 0.0017 - acc: 0.998 - ETA: 0s - loss: 0.0030 - acc: 0.998 - ETA: 0s - loss: 0.0024 - acc: 0.998 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.998 - ETA: 0s - loss: 0.0019 - acc: 0.998 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.998 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0015 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.998 - ETA: 0s - loss: 0.0039 - acc: 0.998 - ETA: 0s - loss: 0.0037 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.9988Epoch 00054: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0040 - acc: 0.9988 - val_loss: 1.1834 - val_acc: 0.8335
Epoch 56/64
6336/6680 [=====>..] - ETA: 1s - loss: 5.2061e-07 - acc: 1.000 - ETA: 0s - loss: 2.1713e-07 - acc: 1.000 - ETA: 0s - loss: 2.4098e-07 - acc: 1.000 - ETA: 0s - loss: 5.2128e-04 - acc: 1.000 - ETA: 0s - loss: 6.4506e-04 - acc: 1.000 - ETA: 0s - loss: 0.0034 - acc: 0.9995 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0020 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.9989Epoch 00055: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9990 - val_loss: 1.1905 - val_acc: 0.8359

Epoch 57/64

6464/6680 [=====>.] - ETA: 1s - loss: 1.1921e-07 - acc: 1.000 - ETA: 0s - loss: 1.4991e-04 - acc: 1.000 - ETA: 0s - loss: 8.7872e-05 - acc: 1.000 - ETA: 0s - loss: 2.4410e-04 - acc: 1.000 - ETA: 0s - loss: 0.0024 - acc: 0.9993 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0021 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0030 - acc: 0.999 - ETA: 0s - loss: 0.0038 - acc: 0.999 - ETA: 0s - loss: 0.0035 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.999 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0047 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.9991Epoch 00056: val_loss did not improve

6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9991 - val_loss: 1.1922 - val_acc: 0.8359

Epoch 58/64

6400/6680 [=====>..] - ETA: 1s - loss: 2.7847e-07 - acc: 1.000 - ETA: 1s - loss: 2.5891e-07 - acc: 1.000 - ETA: 0s - loss: 3.4713e-07 - acc: 1.000 - ETA: 0s - loss: 2.9408e-07 - acc: 1.000 - ETA: 0s - loss: 3.7241e-04 - acc: 1.000 - ETA: 0s - loss: 2.9576e-04 - acc: 1.000 - ETA: 0s - loss: 5.2333e-04 - acc: 1.000 - ETA: 0s - loss: 4.5817e-04 - acc: 1.000 - ETA: 0s - loss: 0.0022 - acc: 0.9997 - ETA: 0s - loss: 0.0020 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.999 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0033 - acc: 0.999 - ETA: 0s - loss: 0.0046 - acc: 0.999 - ETA: 0s - loss: 0.0052 - acc: 0.999 - ETA: 0s - loss: 0.0050 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.9991Epoch 00057: val_loss did not improve

6680/6680 [=====] - 1s - loss: 0.0045 - acc: 0.9991 - val_loss: 1.2063 - val_acc: 0.8275

Epoch 59/64

6464/6680 [=====>.] - ETA: 1s - loss: 1.1921e-07 - acc: 1.000 - ETA: 0s - loss: 8.6664e-07 - acc: 1.000 - ETA: 0s - loss: 1.6169e-05 - acc: 1.000 - ETA: 0s - loss: 5.3514e-04 - acc: 1.000 - ETA: 0s - loss: 3.9561e-04 - acc: 1.000 - ETA: 0s - loss: 0.0030 - acc: 0.9995 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0020 - acc: 0.999 - ETA: 0s - loss: 0.0018 - acc: 0.999 - ETA: 0s - loss: 0.0017 - acc: 0.999 - ETA: 0s - loss: 0.0016 - acc: 0.999 - ETA: 0s - loss: 0.0022 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0045 - acc: 0.9991Epoch 00058: val_loss did not improve

6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9991 - val_loss: 1.2121 - val_acc: 0.8311

Epoch 60/64

6464/6680 [=====>.] - ETA: 1s - loss: 1.1921e-07 - acc: 1.000 - ETA: 0s - loss: 3.5364e-07 - acc: 1.000 - ETA: 0s - loss: 5.0254e-07 - acc: 1.000 - ETA: 0s - loss: 4.6500e-07 - acc: 1.000 - ETA: 0s - loss: 3.3453e-04 - acc: 1.000 - ETA: 0s - loss: 6.5749e-04 - acc: 0.999 - ETA: 0s - loss: 7.6048e-04 - acc: 0.999 - ETA: 0s - loss: 6.6865e-04 - acc: 0.999 - ETA: 0s - loss: 8.9138e-04 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.9994 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0047 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.999 - ETA: 0s - loss: 0.0052 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0053 - acc: 0.998 - ETA: 0s - loss: 0.0050 - acc: 0.998 - ETA: 0s - loss: 0.0048 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.9989Epoch 00059: val_loss did not improve

6680/6680 [=====] - 1s - loss: 0.0044 - acc: 0.9990 - val_loss: 1.1986 - val_acc: 0.8311

Epoch 61/64

6656/6680 [=====>.] - ETA: 1s - loss: 3.0641e-07 - acc: 1.000 - ETA: 1s - loss: 0.0031 - acc: 0.9974 - ETA: 0s - loss: 0.0015 - acc: 0.998 - ETA: 0s - loss: 0.0010 - acc: 0.999 - ETA: 0s - loss: 7.6415e-04 - acc: 0.999 - ETA: 0s - loss: 6.1137e-04 - acc: 0.999 - ETA: 0s - loss: 8.2767e-04 - acc: 0.999 - ETA: 0s - loss: 7.0657e-04 - acc: 0.999 - ETA: 0s - loss: 6.1644e-04 - acc: 0.999 - ETA: 0s - loss: 5.4753e-04 - acc: 0.999 - ETA: 0s - loss: 6.1562e-04 - acc: 0.999 - ETA: 0s - loss: 5.6766e-04 - acc: 0.999 - ETA: 0s - loss: 5.2694e-04 - acc: 0.999 - ETA: 0s - loss: 4.9139e-04 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.9994 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0041 - acc: 0.998 - ETA: 0s - loss: 0.0045 - acc: 0.998 - ETA: 0s - loss: 0.0042 - acc: 0.9988Epoch 00060: val_loss did not improve

6680/6680 [=====] - 1s - loss: 0.0042 - acc: 0.9988 - val_loss: 1.2153 - val_acc: 0.8287

Epoch 62/64

6400/6680 [=====>..] - ETA: 1s - loss: 2.4308e-07 - acc: 1.000 - ETA: 0s - loss: 2.1301e-07 - acc: 1.000 - ETA: 0s - loss: 2.9473e-07 - acc: 1.000 - ETA: 0s - loss: 5.6972e-04 - acc: 1.000 - ETA: 0s - loss: 4.3387e-04 - acc: 1.000 - ETA: 0s - loss: 9.7671e-04 - acc: 0.999 - ETA: 0s - loss: 0.0026 - acc: 0.9991 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0021 - acc: 0.999 - ETA: 0s - loss: 0.0019 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0043 - acc: 0.998 - ETA: 0s - loss: 0.0041 - acc: 0.999 - ETA: 0s - loss: 0.0039 - acc: 0.999 - ETA: 0s - loss: 0.0044 - acc: 0.9989Epoch 00061: val_loss did not improve

6680/6680 [=====] - 1s - loss: 0.0043 - acc: 0.9990 - val_loss: 1.2050 - val_acc: 0.8323

Epoch 63/64

6400/6680 [=====>..] - ETA: 1s - loss: 1.2796e-05 - acc: 1.000 - ETA: 0s - loss: 0.0011 - acc: 1.0000 - ETA: 0s - loss: 6.1604e-04 - acc: 1.000 - ETA: 0s - loss: 4.2207e-04 - acc: 1.000 - ETA: 0s - loss: 0.0014 - acc: 0.9988 - ETA: 0s - loss: 0.0011 - acc: 0.999 - ETA: 0s - loss: 9.5681e-04 - acc: 0.999 - ETA: 0s - loss: 0.0011 - acc: 0.9989 - ETA: 0s - loss: 9.6558e-04 - acc: 0.999 - ETA: 0s - loss: 8.7627e-04 - acc: 0.999 - ETA: 0s - loss: 8.0246e-04 - acc: 0.999 - ETA: 0s - loss: 7.2854e-04 - acc: 0.999 - ETA: 0s - loss: 6.6708e-04 - acc: 0.999 - ETA: 0s - loss: 7.5454e-04 - acc: 0.999 - ETA: 0s - loss: 0.0024 - acc: 0.9991 - ETA: 0s - loss: 0.0023 - acc: 0.999 - ETA: 0s - loss: 0.0040 - acc: 0.998 - ETA: 0s - loss: 0.0043 - acc: 0.9988Epoch 00062: val_loss did not improve

6680/6680 [=====] - 1s - loss: 0.0041 - acc: 0.9988 - val_loss: 1.1948 - val_acc: 0.8311

Epoch 64/64

6528/6680 [=====>.] - ETA: 0s - loss: 4.6380e-07 - acc: 1.000 - ETA: 0s - loss: 2.6356e-07 - acc: 1.000 - ETA: 0s - loss: 2.4435e-07 - acc: 1.000 - ETA: 0s - loss: 2.5670e-07 - acc: 1.000 - ETA: 0s - loss: 2.6623e-07 - acc: 1.000 - ETA: 0s - loss: 3.2020e-04 - acc: 1.000 - ETA: 0s - loss: 8.5540e-04 - acc: 0.999 - ETA: 0s - loss:

```
0.0045 - acc: 0.9988 - ETA: 0s - loss: 0.0040 - acc: 0.999 - ETA: 0s - loss: 0.0036 - acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0029 - acc: 0.999 -
ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0027 - acc: 0.999 - ETA: 0s - loss: 0.0025 - acc: 0.999 - ETA: 0s - loss: 0.0028 - acc: 0.999 - ETA: 0s - loss: 0.0026 -
acc: 0.999 - ETA: 0s - loss: 0.0032 - acc: 0.999 - ETA: 0s - loss: 0.0048 - acc: 0.9988Epoch 00063: val_loss did not improve
6680/6680 [=====] - 1s - loss: 0.0047 - acc: 0.9988 - val_loss: 1.2025 - val_acc: 0.8311
```

```
<keras.callbacks.History at 0x2016b8df978>
```

(IMPLEMENTATION) Load the Model with the Best Validation Loss

```
### TODO: Load the model weights with the best validation loss.

# load train data
model_ResNet50.load_weights('saved_models/weights.best.ResNet50.hdf5')
```

(IMPLEMENTATION) Test the Model

Try out your model on the test dataset of dog images. Ensure that your test accuracy is greater than 60%.

```
### TODO: Calculate classification accuracy on the test dataset.

# get index of predicted dog breed for each image in test set
ResNet50_predictions = [np.argmax(model_ResNet50.predict(np.expand_dims(feature, axis=0))) for feature in test_Resnet50]

# report test accuracy
test_accuracy = 100*np.sum(np.array(ResNet50_predictions)==np.argmax(test_targets, axis=1))/len(ResNet50_predictions)
print('Test accuracy: %.4f%%' % test_accuracy)
```

```
Test accuracy: 82.0574%
```

(IMPLEMENTATION) Predict Dog Breed with the Model

Write a function that takes an image path as input and returns the dog breed ([Affenpinscher](#), [Afghan_hound](#), etc) that is predicted by your model.

Similar to the analogous function in Step 5, your function should have three steps:

1. Extract the bottleneck features corresponding to the chosen CNN model.
2. Supply the bottleneck features as input to the model to return the predicted vector. Note that the argmax of this prediction vector gives the index of the predicted dog breed.
3. Use the [dog_names](#) array defined in Step 0 of this notebook to return the corresponding breed.

The functions to extract the bottleneck features can be found in [extract_bottleneck_features.py](#), and they have been imported in an earlier code cell. To obtain the bottleneck features corresponding to your chosen CNN architecture, you need

to use the function

```
extract_{network}
```

where `{network}`, in the above filename, should be one of `VGG19`, `Resnet50`, `InceptionV3`, or `Xception`.

```
### TODO: Write a function that takes a path to an image as input
### and returns the dog breed that is predicted by the model.

# import my Resnet50 func
from extract_bottleneck_features import extract_Resnet50

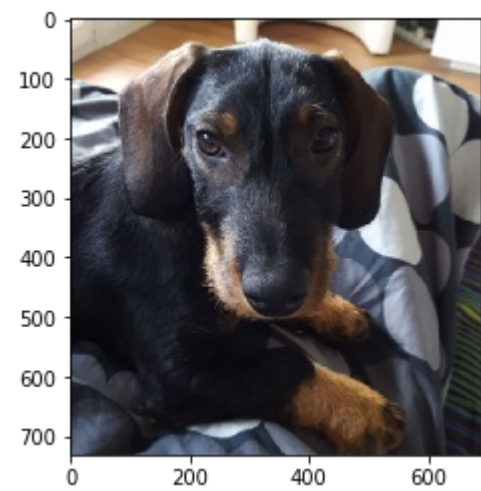
# template from step 5, return name
def getPredictBreedFromResNet50(imagePath):
    # extract bottleneck features
    bottleneck_feature = extract_Resnet50(path_to_tensor(imagePath))
    # obtain predicted vector
    predicted_vector = model_ResNet50.predict(bottleneck_feature)
    # return dog breed that is predicted by the model
    return dog_names[np.argmax(predicted_vector)]

# test helpers to check if getPredictBreedFromResNet50 is correct impl.
# func show image from path
def showImageTest(imagePath):
    image = cv2.imread(imagePath)
    cv_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    imgplot = plt.imshow(cv_rgb)

# func to predict and show the image
def getDogBreedFromImageTest(imagePath):
    if (dog_detector(imagePath)):
        print('Dog Breed is: {}'.format(getPredictBreedFromResNet50(imagePath)))
        showImageTest(imagePath)
    else:
        print('Human Person:')
        showImageTest(imagePath)
```

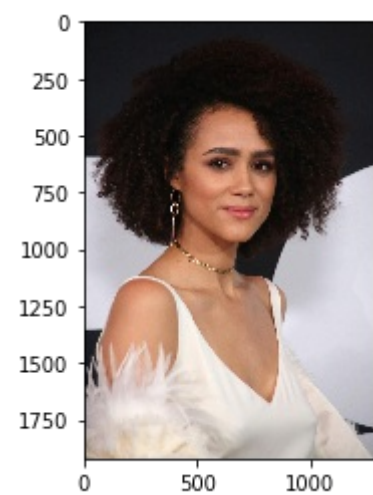
```
# test with Robbi
getDogBreedFromImageTest('images/Robbi_Rauhaardackel_im_Tierheim_2.png')
```

Dog Breed is: Dachshund



```
# test with Nathalie Emmanuel  
getDogBreedFromImageTest('images/nathalie-emmanuel.jpg')
```

Human Person:



Step 6: Write your Algorithm

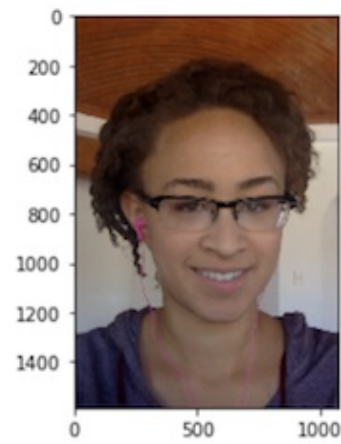
Write an algorithm that accepts a file path to an image and first determines whether the image contains a human, dog, or neither. Then,

- if a **dog** is detected in the image, return the predicted breed.
- if a **human** is detected in the image, return the resembling dog breed.
- if **neither** is detected in the image, provide output that indicates an error.

You are welcome to write your own functions for detecting humans and dogs in images, but feel free to use the `face_detector` and `dog_detector` functions developed above. You are **required** to use your CNN from Step 5 to predict dog breed.

Some sample output for our algorithm is provided below, but feel free to design your own user experience!

hello, human!



You look like a ...
Chinese_shar-pei

(IMPLEMENTATION) Write your Algorithm

```
### TODO: Write your algorithm.
### Feel free to use as many code cells as needed.

# helper func to show first three places
def getDogPredictFirstThreePlaces(imagePath):
    # extract bottleneck features
    bottleneck_feature = extract_Resnet50(path_to_tensor(imagePath))

    # obtain predicted vector list
    predicted_vector = model_ResNet50.predict(bottleneck_feature)[0]

    breeds = [dog_names[index] for index in np.argsort(predicted_vector)[: -1][ :3]]
    scores = np.sort(predicted_vector)[: -1][ :3]

    print('The first three places:')
    for index, (breed, score) in enumerate(zip(breeds, scores)):
        print('nr: {}, {}, score: {:.6f}'.format(index + 1, breed, score))
    showImage(imagePath)

# helper func to show Image from path
def showImage(imagePath):
    image = cv2.imread(imagePath)
    cv_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    imgplot = plt.imshow(cv_rgb)

# helper func get dog breed and show image
def getDogBreedFromImage(imagePath):
    if (dog_detector(imagePath)):
        print('dog breed and looks like a: {}'.format(getPredictBreedFromResNet50(imagePath)))
        showImage(imagePath)

# helper func get human
```

```
def getHumanFromImage(imagePath):
    if (face_detector(imagePath)):
        print('human person and looks like a: {}'.format(getPredictBreedFromResNet50(imagePath)))
        showImage(imagePath)

# helper func get neither from image
def getNeitherFromImage(imagePath):
    if (not face_detector(imagePath) and not dog_detector(imagePath)):
        print('it is not classified... ERROR!')
        showImage(imagePath)

# my algorithm impl.
def getClassifiedFromImage(imagePath, firstThreePlaces = False):
    if(face_detector(imagePath)):
        getHumanFromImage(imagePath)
    elif(dog_detector(imagePath) and firstThreePlaces):
        getDogPredictFirstThreePlaces(imagePath)
    elif(dog_detector(imagePath) and not firstThreePlaces):
        getDogBreedFromImage(imagePath)
    else:
        getNeitherFromImage(imagePath);
```

Step 7: Test Your Algorithm

In this section, you will take your new algorithm for a spin! What kind of dog does the algorithm think that **you** look like? If you have a dog, does it predict your dog's breed accurately? If you have a cat, does it mistakenly think that your cat is a dog?

(IMPLEMENTATION) Test Your Algorithm on Sample Images!

Test your algorithm at least six images on your computer. Feel free to use any images you like. Use at least two human and two dog images.

Question 6: Is the output better than you expected 😊 ? Or worse 😞 ? Provide at least three possible points of improvement for your algorithm.

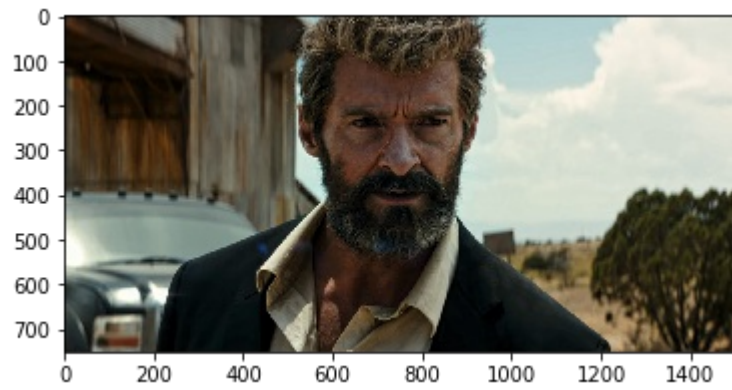
Answer:

- very good results in a short time, better than I expected
- interesting point the wolf is recognized as human 😊
- improvement: dogs with clothing are not recognized but they should (Akita example)
- improvement: additional animals with coat classification for a clear expectation
- improvement: animal sounds (audio) and motion classification (video) for better expectation

```
## TODO: Execute your algorithm from Step 6 on
## at least 6 images on your computer.
## Feel free to use as many code cells as needed.

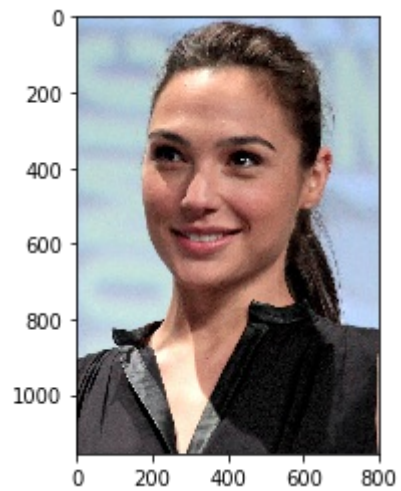
getClassifiedFromImage('images/Logan_-_Wolverine.jpg')
```

human person and looks like a: German_pinscher



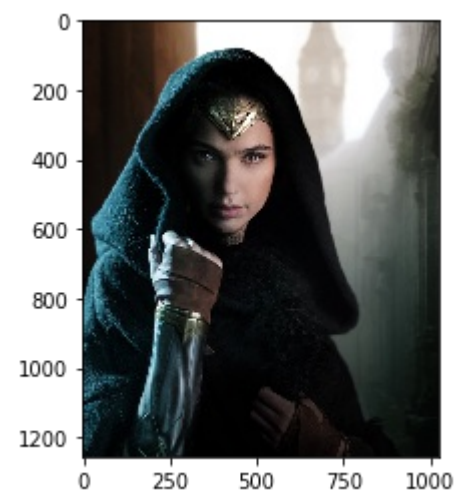
```
getClassifiedFromImage('images/Gal_Gadot_2_SDCC_2014_(cropped).jpg')
```

human person and looks like a: English_springer_spaniel



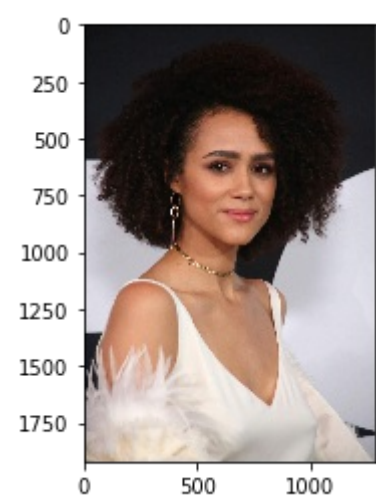
```
getClassifiedFromImage('images/gadot-wonder-woman.jpg')
```

human person and looks like a: Cane_corso



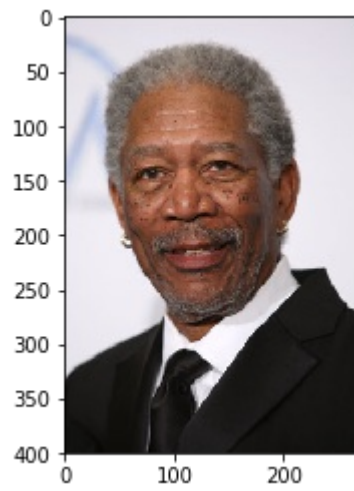
```
getClassifiedFromImage('images/nathalie-emmanuel.jpg')
```

human person and looks like a: Havanese



```
getClassifiedFromImage('images/MorganFreeman.jpg')
```

human person and looks like a: Doberman_pinscher



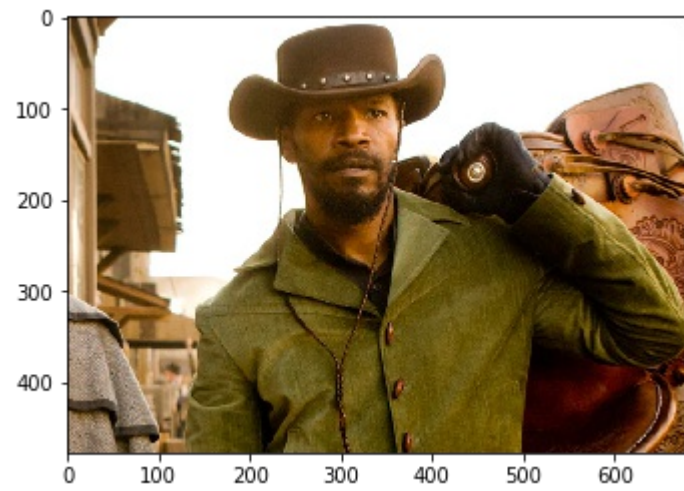
```
getClassifiedFromImage('images/Captain-America-Chris-Evans-and-The-Winter-Soldier-Sebastian-Stan.jpg')
```

human person and looks like a: Xoloitzcuintli



```
getClassifiedFromImage('images/jamie-foxx-django-unchained.jpg')
```

human person and looks like a: Xoloitzcuintli



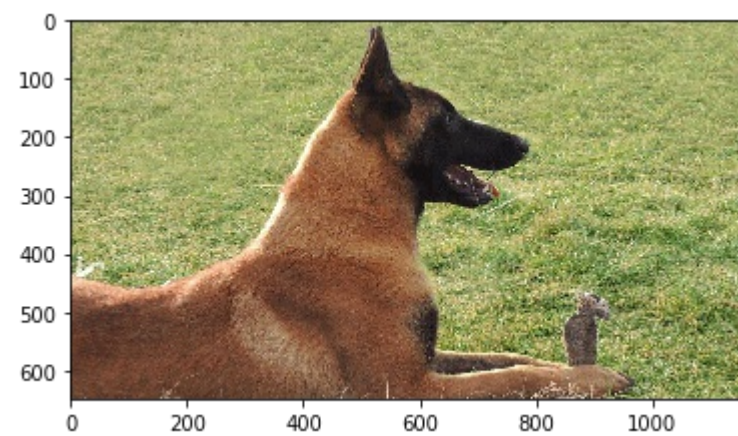
```
getClassifiedFromImage('images/Black_Widow_Avengers.jpg')
```

human person and looks like a: Black_russian_terrier



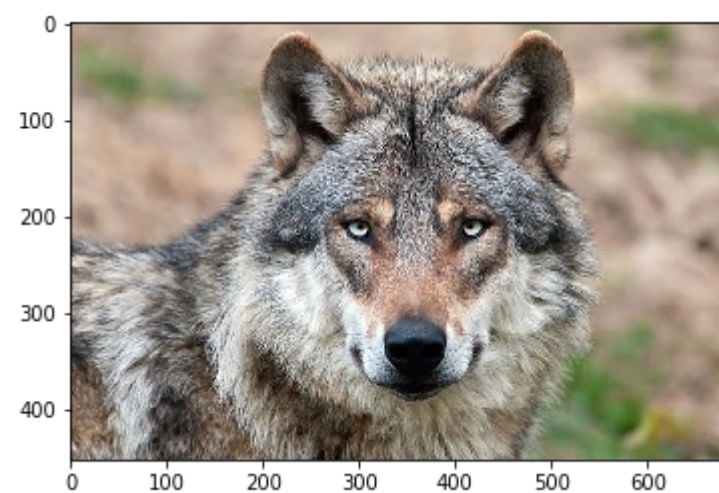
```
getClassifiedFromImage('images/Malinois.png',True)
```

The first three places:
nr: 1, Belgian_malinois, score: 0.995435
nr: 2, Giant_schnauzer, score: 0.004385
nr: 3, Afghan_hound, score: 0.000083



```
getClassifiedFromImage('images/wolf_1.jpeg')
```

human person and looks like a: Australian_cattle_dog



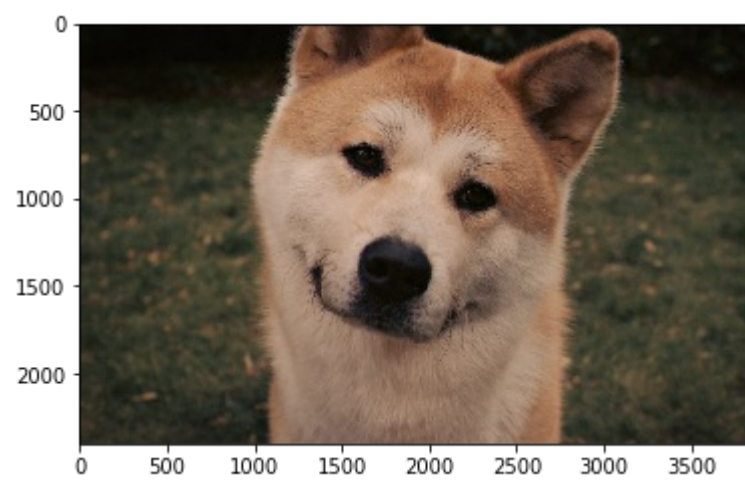
```
getClassifiedFromImage('images/akita_2.jpg')
```

it is not classified... ERROR!



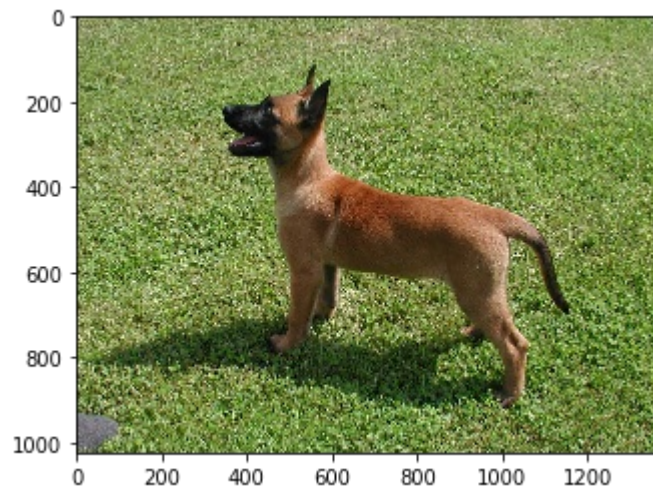
```
getClassifiedFromImage('images/akita.jpg')
```

```
it is not classified... ERROR!
```



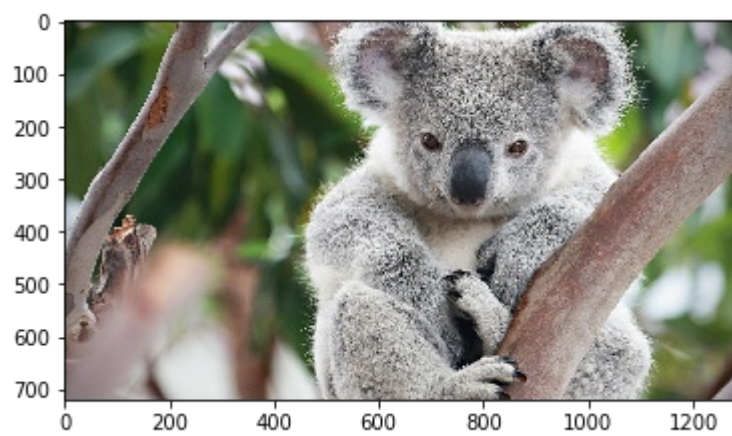
```
getClassifiedFromImage('images/Malinois_junior.jpg')
```

```
dog breed and looks like a: Belgian_malinois
```



```
getClassifiedFromImage('images/koalas.jpg')
```

it is not classified... ERROR!



```
getClassifiedFromImage('images/Robbi_Rauhaardackel_im_Tierheim_2.png', True)
```

The first three places:

nr: 1, Dachshund, score: 1.000000

nr: 2, German_wirehaired_pointer, score: 0.000000

nr: 3, Bluetick_coonhound, score: 0.000000

