Capstone Project

Machine Learning Engineer
Nanodegree

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CNN Project: Dog Breed Classifier

Domain Background

Convolutional Neural Networks (CNN) project “Dog Breed Classifier” is a Udacity suggested Project. This project hopes to identify dog breeds from images. This is a fine-grained classification problem: most of the breeds share similar body features and overall structure, so differentiating between breeds is a difficult problem. Furthermore, there is low inter-breed and high intra-breed variation; in other words, there are relatively few differences between breeds and relatively large differences within breeds, differing in size, shape, and color.

The aim of the project was to develop an algorithm where the code will accept any user supplied image as an input in order to identify dog breeds from images, If a dog is detected in an image, it will provide an estimate of the dog’s breed. and If supplied an image of a human, the code will identify the resembling dog breed.

This problem is not only challenging but also its solution is applicable to other such classification and image recognition problems. For instance, the methods used to solve this problem would also help identify breeds of cats and horses as well as species of birds and plants or even models of cars. Any set of classes with relatively small variation within it can be solved as a fine-grained classification problem. In the real-world, an identifier like this could be used in biodiversity studies, helping scientists save time and resources when conducting studies about the health and abundance of certain species populations. Breed prediction can also assist in identifying dogs that need medical care.

Ultimately, I have found dogs to be the most interesting class to experiment with due to their immense diversity, loving nature, and abundance in photographs, but I also hope to expand our understanding of the fine-grained classification problem and provide a useful tool for scientists across disciplines.

Problem Statement

The goal is to build a model capable of identifying to which breed a dog belongs, based only on its photo which is a fine grained classification problem. There are several factors that make the problem of dogs categorization challenging like noise in the photos, and small datasets. Moreover, there are many different breeds of dogs exist, and all breeds on a high-level look alike and might not be obvious right away.

The purpose of the project is to use a convolutional neural network (CNN) for the classification of dog breeds which allows computers to automatically extract hierarchies of features from raw pixels. Transfer learning approach will be applied to increase the accuracy which focuses on storing knowledge gained while solving one problem and applying it to a different but related problem. Since the feature extraction process is the most complex modeling challenge, reusing it allows you to train a new model with less computational resources and training time.

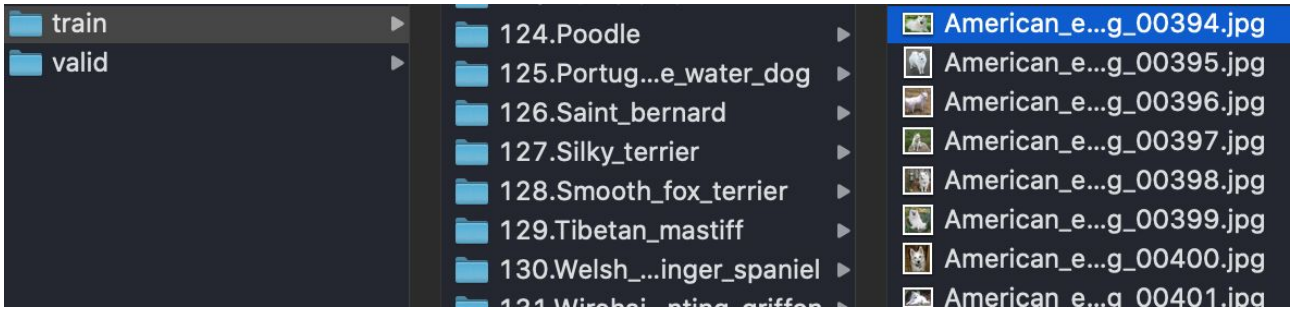
Datasets / Inputs

Our datasets, which I plan to use were provided by Udacity in pre-filled Jupyter notebook (**dog_app.ipynab)** which includes in total **8351** dog & **13233** human images

File descriptions

- **/dog_images**: Dog Images
- **/lfw:** Human images

The most important file is **/dog_images** training set images, we have 8351 training examples. In this case, it was trivial, as Udacity provided me with 1.08Gb of dog images spanning 133 breeds, already in a proper file structure means files are segregated by training, validation, and testing, and further segregated within these folders by dog breed.



Solution Metrics

This project proposed breed classification based on convolutional neural network. The model is extended by applying transfer learning on the given datasets that shifts pre-trained Visual Geometry Group (VGG) model to the next model and consequently increased the resilience and efficiency of the model. Subsequently, the model is tested by

the given data sets to validate its accuracy by returning the corresponding dog breed of human or dog images.

Benchmark Model

Conventionally, face recognition and breed classification relied upon hand-crafted features, such as edges and texture descriptors, combined with machine learning techniques, such as principal component analysis, linear discriminant analysis or support vector machines. Conventional face recognition methods have been surpassed by deep learning methods based on convolutional neural networks (CNNs) with high accuracy and robustness acquired by learning from actual deviations appearing in the images. For the sake of benchmarking, we will restrict the CNN till 100 Epochs and extend by using Transfer learning which trains and validates the classification of dog breeds.

Evaluation Metrics

We are only going to focus on an accuracy score. The goal of what we're looking to do here is: we want to see how well we can do at classifying breeds of dogs and evaluate the quality of the classifier by asking it to predict labels for a new set of images. We will then compare the true labels of these images to the ones predicted by the classifier and Accuracy will be able to tell us in a simple and easy-to-understand way how well our deep learning model is performing in this regard.

Project Design

The official Project design criteria used in **dog_app.ipynab** defined as following:

- 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: Create a CNN to Classify Dog Breeds (using Transfer Learning)
- Step 5: Write your Algorithm
- Step 6: Test Your Algorithm

Step 0: Import Datasets

Required human and dog datasets will be downloaded.

Step 1: Detect Humans

In this section, we will use OpenCV's implementation of Haar feature-based cascade classifiers to detect human faces in images.

Step 2: Detect Dogs

We will use a pre-trained model of pytorch to detect dogs in images.

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

In this step, we need to create a CNN from scratch to classify the dog breeds and the objective is to achieve an accuracy of at least 10% by training and validating the models.

Step 4: Create a CNN to Classify Dog Breeds (using Transfer Learning)

At this stage, we will be using transfer learning to create a CNN that can identify dog breed from images and the objective here would be to achieve an accuracy of at least 60%

Step 5: Write your Algorithm

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

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

Step 6: Test Your Algorithm

At the final stage, we will test using trained datasets to check either we are having a desired accuracy result or not.

References:

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