Capstone Project Proposal - Dog Classifier

Abstract

This project proposal is to create a Machine Learning model that will predict the breed of a dog if an image of dogs supplied by users and predict the closest resembling breed of dog if an image of a human is supplied by users. To do so, we will create a human and dog face classifier and train a Convolutional Neural Network (CNN) to classify the human/ dog face accordingly. Thee training, validation, and testing of the CNN will be done using the human and dog face (structured data) provided by Udacity.

Domain Background

Machine learning (ML) has become more prominent in business and scientific applications over the past decade, driven by advances in computing technology (e.g. GPUs) and the ML algorithms. A common application of ML is in the field of computer vision, in which machines are trained to interpret and understand the visual world. Using digital images from cameras and ML models, machines are used to identify and classify objects — and then react to what they "see."

This project focuses on the problem of classifying dog breeds. This problem has been extensively studied and has been the topic of past Kaggle competitions (i.e., Dog Breed Classification Competition) and numerous academic papers (e.g., Dog Breed Identification Using Deep Learning).

As a dog lover and owner, this application of ML aligns with my personal interest and I look forward to deploying an ML-powered web app that can be used by my friends and family.

Problem Statement

There are two main problems being address by my proposal.

First, we need to classify user-provided images of dogs into the appropriate dog breed. Second, we need to classify user-provided images of humans and return the dog breed that the human bears the closest resemblance to.

This is a supervised learning problem — our dog images are divided into breed classes.

Datasets and Inputs

The training, validation, and test data are existing pre-classified images of dogs and humans provided by Udacity as part of this Capstone Project.

The Udacity dataset contains 8,351 total dog images, sorted into training (6,680 images), testing (836 images), and validation (835 Images) folders. All the images in these folders are sorted in

breed directories. We have 133 folders (dog breeds) in every train, test, and valid directory. These dog images are of different sizes, backgrounds, and angles which should provide enough variety for us to train on.

The Udacity dataset also contains 13,233 total human images. These are sorted by name of the human (presumably). The human images are of the same size, but different backgrounds, positions, and angles.

Solution Statement

The solution will be in two parts.

First I will create a dog and human detector to detect whether there is a dog or human in the image. If the detectors do not detect either, then I will return an error message.

Second, I will train several Convolutional Neural Network (CNN) to classify the dog breed for images that have dogs in them and closest resembling dog breed for images with a human in it. The CNNs will be trained in several ways: from scratch using an existing reference architecture (e.g., VGG-16) and via transfer learning by taking the existing weights of a pre-train model (e.g., VGG-16). In the transfer learning instance, I will retrain the last fully connected layer.

Benchmark Model

The Benchmark Model for the CNN model created from scratch is an accuracy of greater than 10%. This is sufficient to confirm the model works because a random guess would give us <1% accuracy since there are 133 breeds (i.e., 1 divide by 133 = <1%).

The Benchmark Model for our CNN model created via transfer learning must have an accuracy greater than 60%, as per the project requirements.

Evaluation Metrics

Since this is a multi-class classification problem, I will use a multi-class log loss function (as prescribed by the Dog Breed Identification challenge on Kaggle). A simple accuracy score is not a great evaluation metric due to the imbalance in classes in the dataset. This imbalance may not reflect the underlying distribution of user-provided images.

Project Design

The project design will follow the steps outlined in the Udacity notebook. These are:

- Step 0: Import Datasets and perform preprocessing on the image (e.g., image augmentation)

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- Step 1: Detect Humans by using OpenCV's implementation of Haar feature-based cascade classifiers
- Step 2: Detect Dogs by creating a dog detector using a pre-trained VGG-16 model
- 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 an Algorithm to combine the human and dog detectors and apply our CNN accordingly.
- Step 6: Test and evaluate the Algorithm