Dog Breed Classification System

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Abstract

Throughout the centuries, domesticated dogs have been given the title of "man's best friend." As time goes on, more and more breeds of dogs have been introduced into the world. Many of these come in the form of crossbreeds, such as the now-popular Goldendoodle or Cavapoo. Regardless, an increased amount of breeds means more dogs to identify. The need for identification can be useful for all kinds of people, whether that be people seeking to adopt a dog, biologists, or law enforcement. This model was created for classifying dog breeds, trained on 120 different dog breeds from the public Stanford dog breed dataset. Additionally, for those bonded closely with their canine friends, there is the saying that dogs look like their owners. We wanted to test this theory, and decided to incorporate a human face detector which produces an output of what dog breed the input resembles the most.

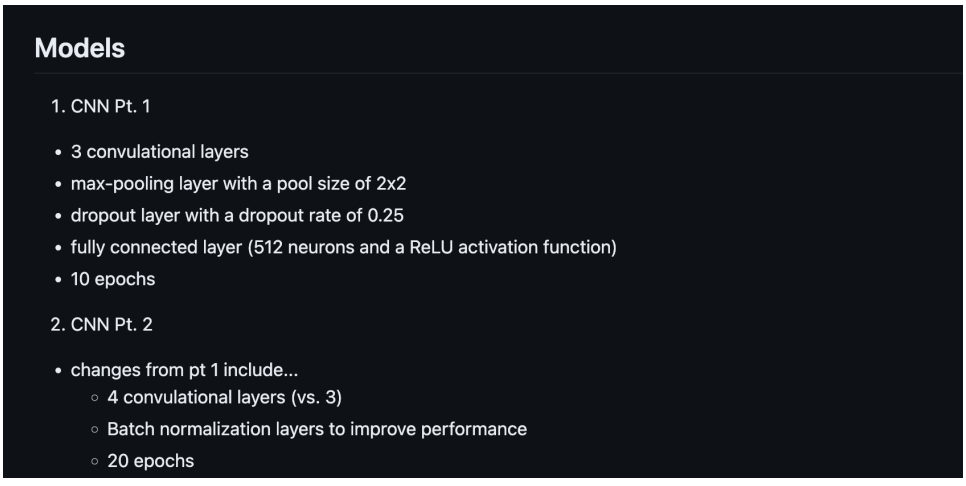
Introduction

We used 2 datasets publicly available on Kaggle - Stanford's dog breed dataset and a human face dataset. The former was composed of 120 different dog breeds with 20,580 images. The latter had 7,219 images of human faces of varying age and gender. We created methods to identify both dog and human faces in a photo. If the model cannot detect either, it will output that. Otherwise, it outputs the predicted dog breed for a dog, or in the case of a human, what dog the human looks most similar to.

We used Tensorflow and Keras, as well as other implementations within those libraries such as ResNet50. Our neural network for breed prediction has 3 convolutional layers, a dense layer with 512 neurons and an ReLU activation function, and a 120-neuron output layer. Our intentions for this model targeted anyone looking to learn more about dogs, examining their evolution (especially when looking at new breeds), or for legal cases in crimes involving dogs. We also wanted to see if we can distinguish a real dog from a fictional dog, such as Northeastern's mascot Paws, or see the results that a mixed-breed dog produces.

Methods

We initially considered a CNN model, adding on to our class assignments and homeworks. Check below for an outline of the two CNN models we ran:



We soon realized that normal CNN models weren't going to perform well for a complex task like a dog breed classification system. Instead, we attempted to work with transfer learning, a technique in machine learning where a pre-trained model on a large dataset is used as a starting point for a new task. Check below for more details on the models we tested for transfer learning:

TRANSFER LEARNING: using pre-trained deep learning model that was trained on a large-scale image classification task

3. XCeption (pre-trained on the ImageNet dataset)

- Sequential model
- Dense layer with 120 neurons and softmax activation function

4. ResNet50 (deep convolutional neural network architecture)

- Dense output layer with 120 neurons and softmax activation function

Results

Check below for a summary of test accuracy for all the models we developed:

Accuracy

Model	Test Accuracy
1: Simple CNN	18.27%
2. CNN (more epochs and deeper architecture)	75.78%
3. Xception	14.16%
4. ResNet 50	90.3%

Simple CNN with an accuracy of 18.27% is the least performing model among the four. It is possible that the architecture of this model is not deep enough to capture the complexity of the dog breed classification system. The increase in epochs and deeper architecture has improved the accuracy significantly compared to the first model. This suggests that the model needs to be sufficiently deep and trained for a sufficient number of epochs to achieve better accuracy.

Xception didn't perform well, however, ResNet 50 performed exceptionally well. In our research, most models that have already been implemented for dog breed classification have accuracy ranging from 85-92%. Therefore, a 90% accuracy is excellent.

Conclusion and Future Steps

We were successful at implementing a model that was able to predict dog breed results accurately, as well as detect dogs and humans in a given photo. Our model was able to detect humans and provide a breed that they most resemble to. It was also able to identify that Paws, Northeastern's mascot, isn't a dog. However, it didn't identify Paws as a Husky. Moreover, more fine-tuning is required to output multi-breed dogs.

If we had more time, we would like to find more dog breeds to train the model on, and introduce more domesticated animals to the model. The likeliest option would be cats, as those are very popular pets. This would prove even more interesting as we input more complex photos with multiple types of animals in them. In terms of human identification, one thing that we noticed is that many of the pictures in the dataset are very professional. We wondered how photos on social media that are much more casual would hold up. This would be very helpful when identifying multiple human faces, and when combined with training on casual photos, that would improve accuracy with human identification. This also introduces the possibility of identifying multiple faces in a photo and giving different dog breed look-alikes for each person.

References

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