DEEPDOGGO: LEARNING THE ANSWER TO "WHO'S A GOOD DOG?"

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ABSTRACT

Humans tend to rate every dog as a good dog. This leads to significant social conflict and suboptimal pet choices. To fix this, we introduce DeepDoggo, the first neural network to classify images of dogs as either good dogs or bad dogs. DeepDoggo is available at deepdoggo.com.

1 INTRODUCTION

For centuries, humans have known that dogs are "man's best friend" (Laveaux & King of Prussia, 1789). But until now, it has been impossible to answer the question: "Which dog is man's *best* best friend?" As Figure 1 shows, the difficult task of evaluating dog goodness has led to significant interpersonal conflict.

Figure 1: When left to their own devices, humans tend to classify every dog as a good dog. This creates social friction. Figure reproduced from WeRateDogs (2016).

One proposed mechanism to evaluate dog goodness includes the training of dogs to perform "tricks"[1]. These "tricks", which include sitting or shaking a paw on instruction, vary in difficulty and quality of execution. Thus, the evaluation of such "tricks" naturally induces a partial ordering on the set of dogs. However, this ordering requires pre-trained dogs.

Unfortunately, the reliance on biological neural networks makes dog training procedures computationally intensive. Even with recent hardware advances, speedups remain fixed at approximately 9 dog years per human year(Larson & Bradley, 2014). These limitations leave dog owners unable to compare the goodness of either untrained dogs or rare puppers. Furthermore, dogs are often good dogs for reasons that are unrelated to tricks (Knight, 1940; Dunham, 1993). As dogs are frequently selected to be pets when they are untrained puppers, our inability to estimate dog goodness has led dog owners to select suboptimal pets.

Here we pursue the natural extension of constructing an artificial neural network to classify dogs as either good dogs or bad dogs. This approach has several advantages over current rating systems. First, it has the ability to evaluate dog goodness for all dogs, not just trained dogs. Secondly, it is extensible to evaluate many facets of dog goodness, such as the ability to get help when one falls in a well. Finally, and perhaps most importantly, it is deep learning.

2 Related Work

There has been almost no related work on this problem as it is completely useless.

3 Data

Pictures were taken from Google Images after searches for "good dog" and "bad dog". As most dogs in the world are very good dogs, we represent this class imbalance by using 360 pictures of bad dogs and 585 pictures of good dogs. Standard data augmentation procedures, including subsamples, translations, and rotations, were followed to generate the full training dataset. Data was split into 60% training data, 20% validation data, and 20% test data.

4 Model

We used the pre-trained Inception-v3 model (Szegedy et al., 2016) as a base, and retrained a final layer to classify dogs as good or bad. This approach is justified because the Inception-v3 model is easy to download in Tensorflow.

5 Results

Our model successfully converged to 73.0% classification accuracy. This is significantly higher than the 61.9% classification accuracy of the naive baseline which labels every dog as a good dog. Representative dogs and their classification labels are shown in Table 1.

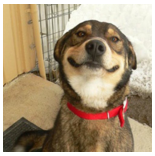
6 Discussion

6.1 The Most Good Dog

A natural question is which dog is the most good dog. Here, we answer this question by identifying the sample in the training set that maximized the good dog output value. The most good dog, with a good dog score of 0.902, can be seen in Figure 2. Areas of significant contribution to the classification label are highlighted in colored rectangles. As these areas are concentrated on the the dog's face, we recommend that dog owners looking to increase the goodness of their dog increase the size of their dog's face. To continue the search for the most good dog, we have constructed the website `deepdoggo.com`, where users can upload new images and receive dog goodness scores.

[1] They're illusions, Michael.

Table 1: Representative Samples

Model	Classification (Goodness)	Ground Truth
	Good (0.895)	Good
	Good (0.732)	Good
	Good (0.566)	Good
	Bad (0.468)	Bad
	Bad (0.350)	Bad
	Bad (0.277)	Bad

6.2 Adversarial Dogs

Unfortunately, adversarial examples can fool this classifier. This is bad; a bad dog wearing an imperceptible noise filter should not be treated the same as a good dog. One adversarial example is shown in Figure 3.

7 Future Work

This work raises several questions for future work. In particular, we are interested in the possibility of training generative models of dog goodness. In a similar spirit to Crichton (2012), generative models will enable us to engineer the next generation of more good dogs.

We are also interested in the implications that this work has for the future of the dog training industry. Current training procedures involve the use of supervised treat-based reinforcement learning; however, it is possible that the rich literature on stochastic optimization will have much to offer the dog training industry.

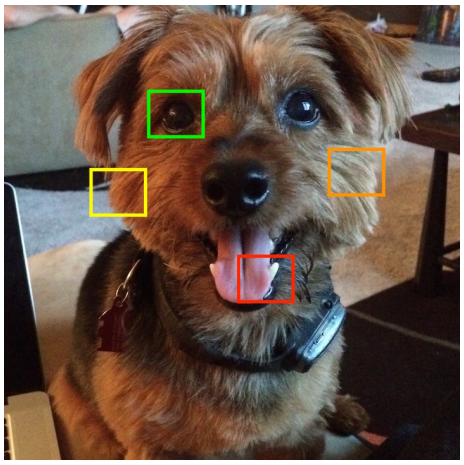


Figure 2: The most good dog from the training set, with areas of significant contribution to the classification label highlighted.

(a) A very good dog.

(b) An imperceptible filter.

(c) An image classified as a bad dog.

Figure 3: When (a) a very good dog and (b) an imperceptible filter are combined, they form (c) an adversarial image which is classified as a bad dog.

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WeRateDogs. they're good dogs brent [tweet]. Twitter, 9 2016.