Binary Image Classifier for Guilty Dog

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Abstract

Domestication over three thousand years has shaped dogs into developing facial muscles in order to communicate with their human owners. The project intends to use a Convolutional Neural Network (CNN) to build a binary image classifier for determining dogs' facial expressions, specifically, identifying the facial expression of guilt.

1 Introduction

Understanding and interpreting facial expressions in dogs is crucial for comprehending their emotional states and behavior. For new puppy owners or individuals with multiple dogs, everyday scenarios like torn blankets or knocked-over objects can be challenging. When it's unclear which dog is responsible for such incidents, valuable lessons might not be effectively learned by the guilty party. With the recent emerging use of CNN in the field of image classification, this report introduces a binary image classifier that employs a CNN to discern whether a dog exhibits a "guilty face" or not.

2 Related Work

There has been a lot of research showing that dogs, compared to others in the Canidae, developed different muscle structures around the eyes [1]. These muscles allow domestic dogs to display facial expressions of happiness, anger, pain, etc, which are used in the clinical recognition of moods[2]. As a result, much research has been conducted to determine a dog's emotional state based on its facial expression. One of which, closely related to this project, uses the CNN as a model for the classifier[3].

3 Proposed Dataset and Approach

Proposed Dataset The project will use the Kaggle dataset of dog emotions `https://www.kaggle.com/datasets/devzohaib/dog-emotions-prediction` as a "not guilty" dataset, and a self-constructed "guilty" dataset from Google Images. To ensure the feasibility and validity of the self-collected pictures, the project will use the Chrome extension "Download All Images", and perform a preprocessing procedure, for example, removing files with a wrong extension name. After collecting, the two "not guilty" and "guilty" datasets should be approximately the same size.

Approach The project is primarily focused on leveraging the power of TensorFlow as its core framework for machine learning. Once the data is integrated into the model's architecture, it will undergo a filtration process through a linear combination of multiple 2D Convolution filters, commonly referred to as Conv2D. These filters, essentially kernel matrices, extract the inherent features and amalgamate them into a singular output pixel. The fully trained model will then make predictions on the unseen images, relying on the characteristics encapsulated within the output pixel.

In the realm of binary image classification, a commonly used technique is the utilization of the Adam optimization algorithm with the binary cross-entropy loss function. In line with these conventions, this project will aim to make use of the Adam optimizer and binary cross-entropy loss alongside other optimization and loss functions, and the presence/ absence of a L2 regularization. This thorough investigation will help us understand the many factors that affect how well models work and make predictions in deep learning.

4 Expected Result and Milestones

- **Nov 10:** Complete at least one consultation with the instructor and finishing revising the report.
- **Nov 20:** Complete data collection and preprocessing.
- **Dec 1:** Complete modeling building and training. Use the testing result to revise the model.
- **Dec 10:** Summarize the result and try using different optimization methods/ loss functions/ regulations. Compare the results in the final report.

References

[1] Juliane Kaminski, Bridget M. Waller, Rui Diogo, Adam Hartstone-Rose, and Anne M. Burrows. Evolution of facial muscle anatomy in dogs. *Proceedings of the National Academy of Sciences*, 116(29):14677–14681, 2019.

[2] Daniel et al. Mota-Rojas. Current advances in assessment of dog's emotions, facial expressions, and their use for clinical recognition of pain. *Animals : an open access journal from MDPI*, vol. 11,11 3334. 22, Nov. 2021.

[3] Liu Y. Mao, Y. Pet dog facial expression recognition based on convolutional neural network and improved whale optimization algorithm. *Sci Rep*, 13, 3314, 2023.