Dog Breed Classification Using Deep Learning

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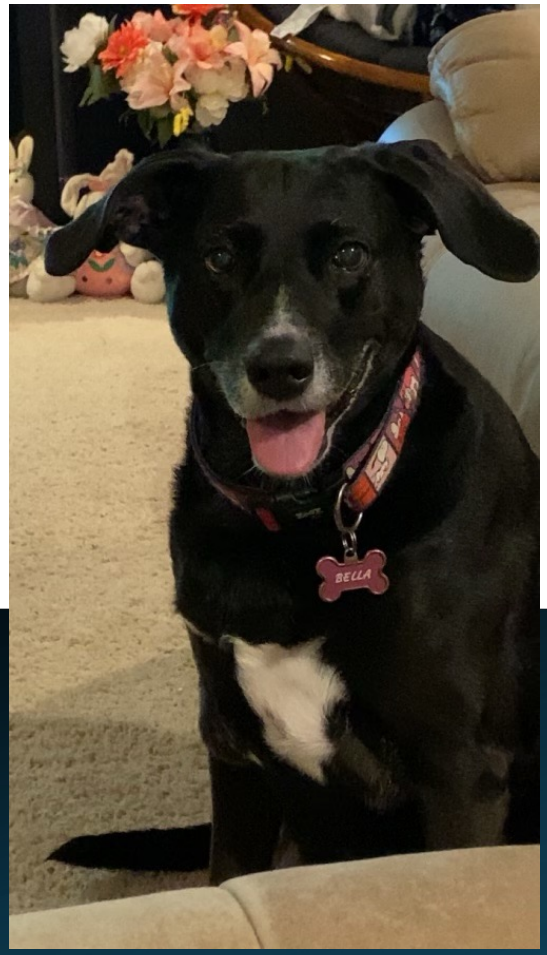
Agenda

- Problem & Challenges
- Motivation
- Existing related approaches
- The method (that you duplicate)
- Results and your observation
- Conclusion and future work

The Problem



Can a dog breed be visually identified simply from a picture using machine learning techniques, deep learning and a trained algorithm?

Challenges

Challenge	Approach
How to train the model?	**The first challenge was to acquire enough image data to train and test the model. The data used was from a Kaggle dataset containing over 20K dog images. These images were then split into training and testing sets for model validation. (Citation below)** **Dog's Breed Identification Dataset** https://www.kaggle.com/c/dog-breed-identification Kaggle Citation: @misc{dog-breed-identification, author = {Will Cukierski}, title = {Dog Breed Identification}, publisher = {Kaggle}, year = {2017}, url = {https://kaggle.com/competitions/dog-breed-identification} }
Computational power and space resources	**The model required large storage and computation power to run in a reasonable amount of time. Google Colab was chosen and a .ipynb Jupyter notebook was created to extract the dog images and build and test the model.** **Despite running on GPU with purchased GPU credits, the average run time was still ~ 1 hour per run. Both A100 and T4 GPUs were used during the execution.**
Which AI model is best to choose?	**The original project I duplicated used ResNet50V2 pre-trained model. I also used two additional models to test results including a VGG pre-trained model and a SimpleCNN model.**

Motivation

My motivation stems from prior work with barcode scanners and the current necessity to scan barcodes to identify products.

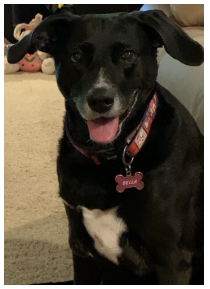
I foresee a future time when barcodes are outdated, and most items can be identified using visual cues.

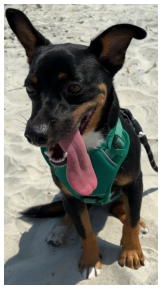
As as result, I am excited to attempt this project of using a dog picture database and machine learning techniques and see if it can identify the breed of a random dog picture.

Goal was to tackle a practical topic relatable to everyday life.

I have several dogs and thought it would be fun to do a "dog" related project with my own dogs as prediction samples.

"Bella"





"Toby"

Existing Related Approaches

(References)

Primary Paper Reference

- Dog Breed Identification using ResNet Model
  - Reddy, Y. A. ., Kumar, Y. S. ., M, S. ., & Mana, S. C. . (2023). Dog Breed Identification using ResNet Model.
  - *International Journal on Recent and Innovation Trends in Computing and Communication*, *11*(7s), 64–71. https://doi.org/10.17762/ijritcc.v11i7s.6977

Supporting Method I Duplicated

- TechVidVan – Dog's Breed Identification using Deep Learning
  - Website - https://techvidvan.com/tutorials/dog-breed-classification/

Supporting Reference Papers & Projects

- Dog Breed Classification Using Deep Learning
  - Varshney, Akash & Katiyar, Abhay & Singh, Aman & Chauhan, Surendra. (2021). Dog Breed Classification Using Deep Learning. 1-5. 10.1109/CONIT51480.2021.9498338.
- Novel Dataset for Fine-Grained Image Categorization
  - Aditya Khosla and Bangpeng Yao and Nityananda Jayadevaprakash and Li Fei-Fei, Novel Dataset for Fine-Grained Image Categorization, First Workshop on Fine-Grained Visual Categorization, IEEE Conference on Computer Vision and Pattern Recognition,2011,June, Colorado Springs, CO, @inproceedings{khosla_fgvc2011}

The Method – Duplicate … Plus 2 Others

Duplicate Method Coding Reference: TechVidVan – Dog's Breed Identification using Deep Learning
Website: https://techvidvan.com/tutorials/dog-breed-classification/

Top Level Summary

- I used Google Colab for the GPU / space resources
- Project used an existing database (Kaggle / Stanford) of dog pictures to train a neural network using transfer learning techniques.
- Trained the model using these pictures and a defined set of labels.
- The overall model is tested for accuracy, target 80%+.
- Finally, present some personal dog photos and see if the model can successfully identify the breed.

Main Technologies

1) Python
2) Tensorflow: 2.3.1
3) Opencv
4) Sklearn

Continued …

5) Numpy
6) Pandas
7) Matplotlib
8) ResNet50V2 - Pretrained Residual Neural Network

Major Project Steps – Shared for All 3 Models

1) Import necessary libraries and prepare coding environment
2) Download and ingest dog photos from my google drive
3) Cut dataset in half to only train / test for 60 dog breeds
4) Encode, scale and augment dog pictures
5) Split pictures into training / test sets (80/20)

RestNet50v2 - Duplicate

6) Build the model
7) Train the model
8) Test the model
9) Predict breed using personal photos
10) Summarize results

VGG - Contributed

6) Build the model
7) Train the model
8) Test the model
9) Predict breed using personal photos
10) Summarize results

SimpleCNN - Contributed

6) Build the model
7) Train the model
8) Test the model
9) Predict breed using personal photos
10) Summarize results

Results Comparisons – 3 AI Models

ResNet50V2 (Duplicated)

Best

5 Epochs
- Training Accuracy: 78%
- Test Accuracy: 78%
- Correct Predictions: 5/5

10 Epochs
- Training Accuracy: 91%
- Correct Predictions: 4/5

20 Epochs
- Training Accuracy: 91%
- Correct Predictions: 4/5

VGG (Contributed)

OK

50 Epochs
- Training Accuracy: 58%
- Test Accuracy: 35%
- Correct Predictions: 3/5

100 Epochs
- Training Accuracy: 64%
- Test Accuracy: 35%
- Correct Predictions: 2/5

Prediction Test Images

Rottweiler | Labrador | Min. Pincher | Irish Deerhound | Whippet

SimpleCNN (Contributed)

Poor

30 Epochs
- Test Accuracy: 4.5%
- Correct Predictions: 0/5

100 Epochs
- Test Accuracy: 11%
- Correct Predictions: 1/5

200 Epochs
- Test Accuracy: 12%
- Correct Predictions: 0/5

Observations / Conclusions

Duplicated Model (ResNet50v2)

- The ResNet50V2 deep learning pre-trained model performed the best overall.
  - The TechVidVan model which was duplicated achieved accuracy of 80.5% with 20 epochs.
  - The motivation original paper "Dog Breed Identification using ResNet Model" Reddy, Y. A., Kumar, Y. S. ., M, S. ., & Mana, S. C. . (2023) achieved accuracy of 91% with 120 epochs
- My best result using the ResNet50v2 model was a training accuracy of 91% using 10 epochs. I achieved the same accuracy with 20 epochs.
- **Observations**
  - Accuracy improved from 78% to 91% from 5 epochs to 10, but did not improve over 91%
  - Interestingly, the 5 epoch model with only 78% accuracy correctly predicted all 5 dog breeds on the test pictures. The 91% accuracy 10/20 epoch models only correctly predicted 4 of 5 test pictures.

Contributed Models (VGG / SimpleCNN)

My attempts to improve beyond the results of the ResNet50v2 model failed.

- The best results of the VGG pre-trained model were a training accuracy of 64%, test accuracy of 35% and 3 of 5 correct predictions.
  - The VGG model shows promise and with enough experimentation may be able improve to a higher accuracy. However, I believe its not capable of matching the performance of ResNet50v2.
- The best results of the SimpleCNN model were a test accuracy of 12% and 1 of 5 correct predictions.
  - The SimpleCNN model appears to not have the learning horsepower for complex visuals in three channels (RGB) or 20k images are not enough for effective training.

Conclusions

- The choice of AI model is critical to the results. The same preprocessed pictures were used in all three models, but the models had widely different performance results.
- The accuracy was improved using the pre-trained models (Resnet50v2/VGG)
- In general, more training epochs resulted in higher training accuracy, some models greatly benefitted from additional training (ResNet50v2) and others only improved slightly (VGG/SimpleCNN)
- The benefits of training eventually eventually tapered off with very little to no benefit.
- Even the Resnet50v2 model with a training accuracy of 91% was not able to correctly predict 5 pictures reliably.

Thank You