# Identify Dog breed using CNN

## 1. Introduction

Machine learning, a rapidly evolving field, has been significantly influenced by technological advancements. Its ability to automate data analysis has gained substantial momentum. While certain machine learning algorithms have existed for some time, recent technological progress has enabled us to efficiently apply complex mathematical calculations to large datasets. Machine learning, a subset of artificial intelligence, is grounded in the principle that systems can learn from data, identify patterns, and make decisions with minimal human intervention. The iterative nature of this learning process allows models to continuously improve as they are exposed to more data.[1]

This research sought to investigate the efficacy of image classification techniques for identifying dog breeds. A dataset comprising images of various dog breeds was employed to train and evaluate a classification model. Convolutional Neural Networks (CNNs) were initially explored followed by MobileNetV2.[1] The optimal model was analysed to assess its performance in accurately classifying dog breeds. Insights from these results guided the identification of potential areas for improvement or alternative approaches to enhance the system's predictive capabilities.

**2. Related Work**

This research focused on the application of MobileNetV2, a type of Convolutional Neural Network (CNN), for dog breed classification. While CNNs have become a popular choice for image classification, MobileNetV2 was selected for its potential to enhance predictive accuracy. MobileNetV2, a deep CNN pre-trained on the ImageNet dataset, consists of 53 layers and is capable of classifying a wide range of images. It represents a more recent approach compared to Inception.

**3. Materials and Experimental Evaluation**

**3.1 Dataset**

This research focused on a Kaggle dataset of dog breed images[4]. The goal was to identify dog breeds based on their images. The dataset contained 8 unique dog breeds and approximately 900-1000 training images. Each image had a unique identifier that corresponded to its breed, stored in a separate file. For this study, I used only the training data, splitting it into training and testing subsets.

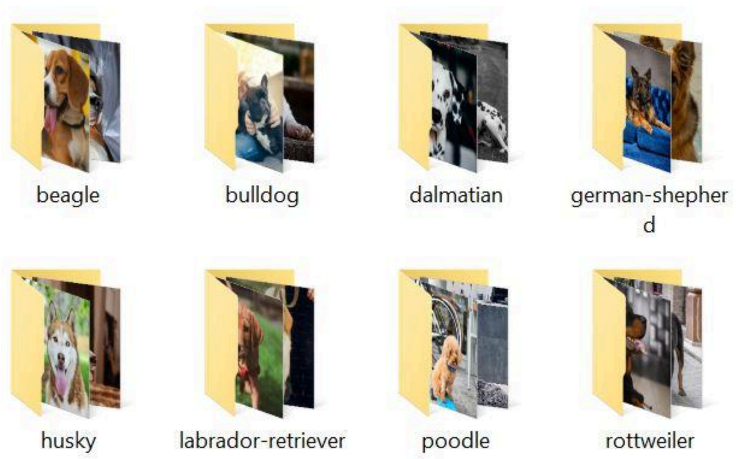


Fig.1 Dataset of dog breeds

### 3.2 Methodology

Initially, I planned to use a MobileNetV2 for dog breed prediction. After designing the model, I began experimenting with different hyperparameters like epochs and batch size. However, initial results were unsatisfactory. To improve performance, I systematically adjusted these parameters, trying various combinations and values. Despite these efforts, the model's accuracy remained suboptimal.There are 8 different classes in the dataset with almost both the classes are equally considered for the experiment.I used 80% of the data for training and 20% for Validation

[1] https://www.kaggle.com/datasets/mohamedchahed/dog-breeds

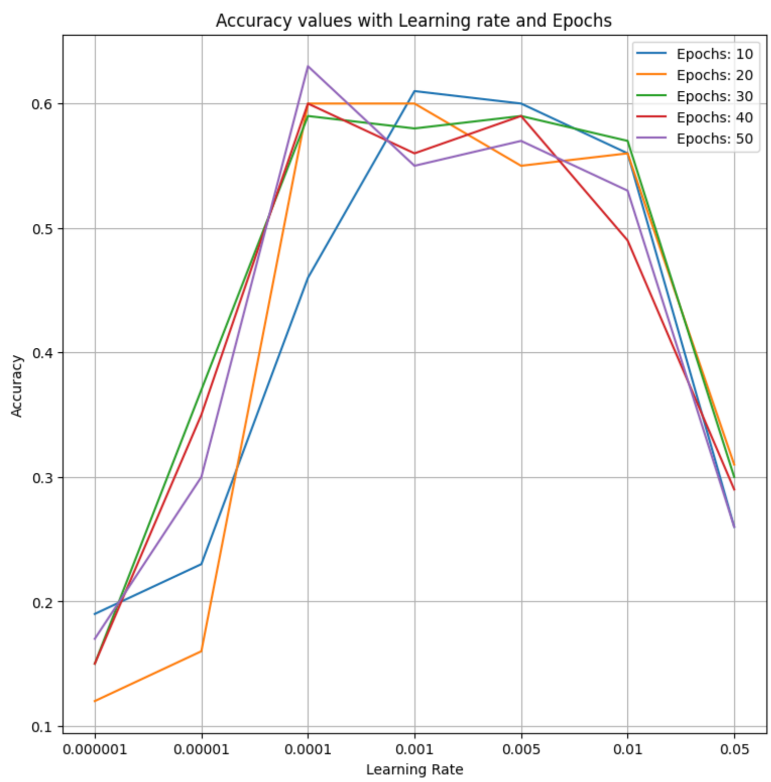


Fig.2 Graph shows the relationship between accuracy, learning rate.

The Fig.2 is a line graph that shows the relationship between accuracy, learning rate, and epochs in a machine learning model. The x-axis represents the learning rate, and the y-axis represents the accuracy. There are five lines in the graph, each representing a different number of epochs (10, 20, 30, 40, and 50). The graph shows that as the learning rate increases, the accuracy generally increases up to a certain point, after which it starts to decrease. The optimal learning rate and number of epochs seem to be around 0.001 and 30-40, respectively.

### 3.3 Results

To evaluate the model's performance, I calculated confusion matrices, true label and predicted label.  Confusion matrices compare predicted dog breeds to actual breeds for individual images, revealing the model's training effectiveness. My optimal model produced the following Fig. 3 shows the confusion matrices for training and testing data.

Example :

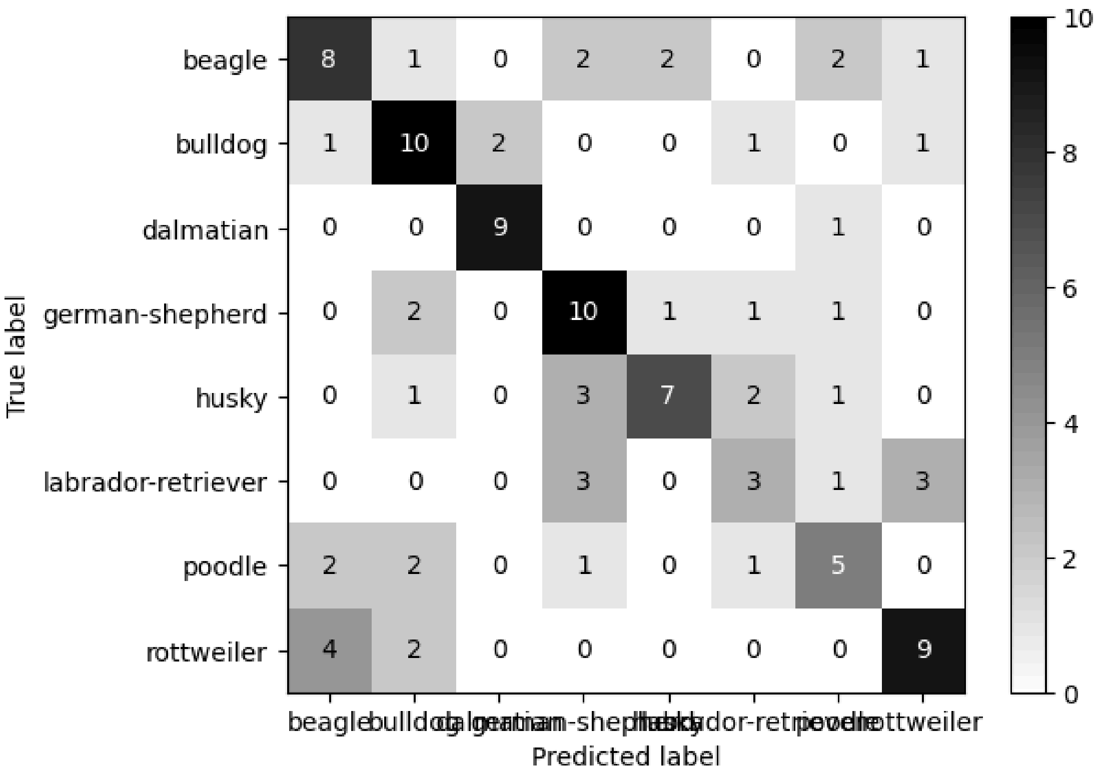


Fig.3 Confusion Matrix

### 3.4 Discussion

**Here's a breakdown of the metrics:**

- **Precision:** The proportion of correctly predicted instances out of all instances predicted for a class.
- **Recall:** The proportion of correctly predicted instances out of all actual instances of a class.

- **F1-score:** The harmonic mean of precision and recall, providing a balanced measure of performance.
- **Support:** The number of instances in each class.

**Key findings from the report:**

- The overall accuracy of the model is 0.58.
- Class 2 has the highest precision and recall, indicating good performance.
- Classes 0, 1, 3, 4, 5, 6, and 7 have varying levels of precision and recall, suggesting room for improvement.
- The macro average and weighted average of the metrics are both 0.58, which provides an overall assessment of the model's performance.

Classification Report :

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.53 | 0.50 | 0.52 | 16 |
| 1 | 0.56 | 0.67 | 0.61 | 15 |
| 2 | 0.82 | 0.90 | 0.86 | 10 |
| 3 | 0.53 | 0.67 | 0.59 | 15 |
| 4 | 0.70 | 0.50 | 0.58 | 14 |
| 5 | 0.38 | 0.30 | 0.33 | 10 |
| 6 | 0.45 | 0.45 | 0.45 | 11 |
| 7 | 0.64 | 0.60 | 0.62 | 15 |
| accuracy | | | 0.58 | 106 |
| macro avg | 0.58 | 0.57 | 0.57 | 106 |
| weighted avg | 0.58 | 0.58 | 0.57 | 106 |

Fig. 4 Classification Report

**4. Future Work**

I acknowledge that MobileNetV2 and ResNet might not be optimal for extremely large datasets. Even with my relatively small dataset of 900-1000 images, the accuracy was only moderately good. The primary goal of this project was to gain experience with machine learning image classification, specifically for dog breeds. In future research, I aim to enhance the prediction accuracy.

**5. Conclusion**

Beyond refining my current model, I'm keen to explore other methods for dog breed prediction. I've already experimented with CNN and MobileNetV2. Comparing these approaches would provide valuable insights into their relative performance. Testing various breed combinations could reveal how this affects accuracy, especially considering the prevalence of different breeds in the dataset.

## 6.Reference


1. Mulligan, Kaitlyn, and Pablo Rivas. "Dog breed identification with a neural network over learned representations from the xception cnn architecture." *21st International conference on artificial intelligence (ICAI 2019)*. 2019.
2. Robert G. De Luna, Arlo Vince O. Cuizon, Jonathan Paul D. Umali, Eldrian M. Latayan, Michael Jethro M. Onte, Havenheu M. Ortega, "Pawfect Match: A User-Interactive Dog Breed Recommendation Powered by Machine Learning", 2024 7th International Conference on Informatics and Computational Sciences (ICICoS), pp.97-102, 2024.
3. B. K. shah, A. Kumar and A. Kumar, "Dog Breed Classifier for Facial Recognition using Convolutional Neural Networks," *2020 3rd International Conference on Intelligent Sustainable Systems (ICISS)*, Thoothukudi, India, 2020, pp. 508-513, doi: 10.1109/ICISS49785.2020.9315871.
4. https://www.kaggle.com/datasets/mohamedchahed/dog-breeds
5. "Dog Breed Identification," Kaggle. [Online]. Available: https://www.kaggle.com/c/dog-breed-identification. [Accessed: 13- Feb-2019].