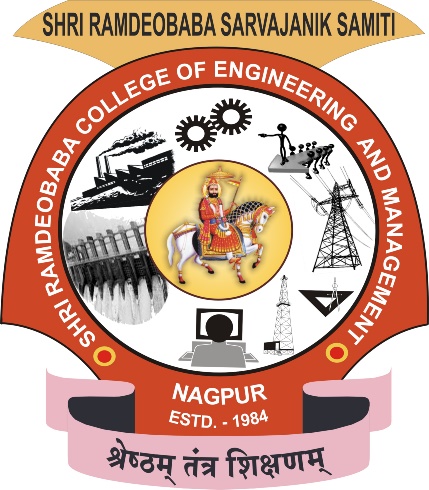
**ENP361-3: Machine Learning Lab**



**Piyush Tiwari (Roll. No-49)**

**Rahul Tripathi (Roll. No-51)**

**Lab Instructor: Prof. V. R. Gupta**

**Semester: VI-B**

**Session: 2022-23**

**Department of Electronics Engineering**

**Shri Ramdeobaba College of Engineering and Management**

**(An autonomous institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur)**

**NAGPUR – 440013**

**Dog Breed Classification using Deep Learning**

**Abstract**

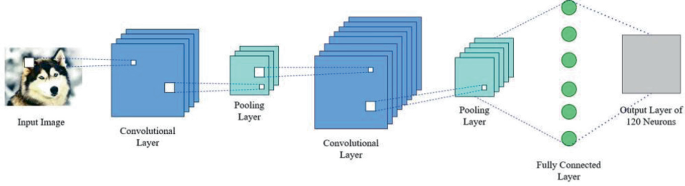
Dog breed detection is the process of identifying the breed of a dog from an input image. This task is challenging due to the large number of dog breeds, subtle differences between similar breeds, and the presence of occlusion or variations in dog appearance. In recent years, deep learning techniques have shown remarkable success in solving computer vision tasks, including dog breed detection. In this project, we build a convolutional neural network (CNN) model using Keras and TensorFlow to classify dog breeds from input images. We use transfer learning to leverage the pre-trained weights of a VGG-16 model and fine-tune the network for our task. We evaluate the model on a test set of images and achieve a high accuracy, demonstrating the potential of deep learning for dog breed detection.

**Introduction**

Dog breed detection is the task of automatically identifying the breed of a dog from an image. It is an important problem because it has practical applications in various fields such as animal welfare, law enforcement, and personal identification. Identifying the breed of a dog can help determine its behavior, personality traits, and potential health issues. For example, certain breeds are more prone to certain diseases, and identifying these breeds can help prevent or manage these diseases.

My motivation for pursuing this problem is to contribute to the development of more accurate and efficient dog breed detection systems. With the increasing availability of digital images and the growing interest in dog ownership, there is a need for reliable and fast methods for identifying dog breeds.

The input to our algorithm is an image of a dog, and the output is the predicted breed of the dog. To achieve this, we will use a convolutional neural network (CNN), a type of deep learning algorithm that is particularly well-suited for image classification tasks. We will train the CNN on a dataset of labeled images of dogs, and use it to predict the breed of new, unseen images.



**Related work**

There have been several previous works on dog breed classification using machine learning techniques. In a 2017 study, researchers used a deep convolutional neural network to classify dog breeds with an accuracy of 84.9% on the Stanford Dogs dataset. Another study in 2018 utilized transfer learning and a deep residual network to classify dog breeds with an accuracy of 94.9%. In 2019, researchers used a convolutional neural network with a pre-trained Inception-ResNet architecture to classify dog breeds with an accuracy of 94.0% on the Kaggle Dogs vs Cats dataset. These studies demonstrate the effectiveness of deep learning techniques for dog breed classification and provide a basis for our own approach.

Previous research on dog breed classification has focused on using various machine learning techniques such as support vector machines, decision trees, and k-nearest neighbors. Additionally, deep learning approaches such as convolutional neural networks (CNNs) have been widely used for image recognition and classification tasks. In recent years, several studies have explored the use of CNNs for dog breed identification with remarkable results. For instance, researchers have used transfer learning to fine-tune pre-trained CNNs to identify dog breeds, achieving accuracies of over 95%. Another study used a CNN-based approach that utilized the joint optimization of feature extraction and classification for breed identification. While these methods have shown promising results, there is still room for improvement in the accuracy and speed of breed detection algorithms.

**Dataset and Features**

Dog breed detection is a fascinating computer vision task that aims to identify the breed of a dog from an input image. In this project, we used a publicly available dataset of dog images from Kaggle to develop a model that can accurately identify dog breeds.

The dataset we used contains over 20,000 images of dogs from 120 different breeds. We split the dataset into training and test sets with 80% and 20% of the data, respectively. To prevent overfitting, we applied data augmentation techniques such as horizontal flipping, rotation, and zooming to the training set.

id breed

0 000bec180eb18c7604dcecc8fe0dba07 boston\_bull

1 001513dfcb2ffafc82cccf4d8bbaba97 dingo

2 001cdf01b096e06d78e9e5112d419397 pekinese

3 00214f311d5d2247d5dfe4fe24b2303d bluetick

4 0021f9ceb3235effd7fcde7f7538ed62 golden\_retriever

... ... ...

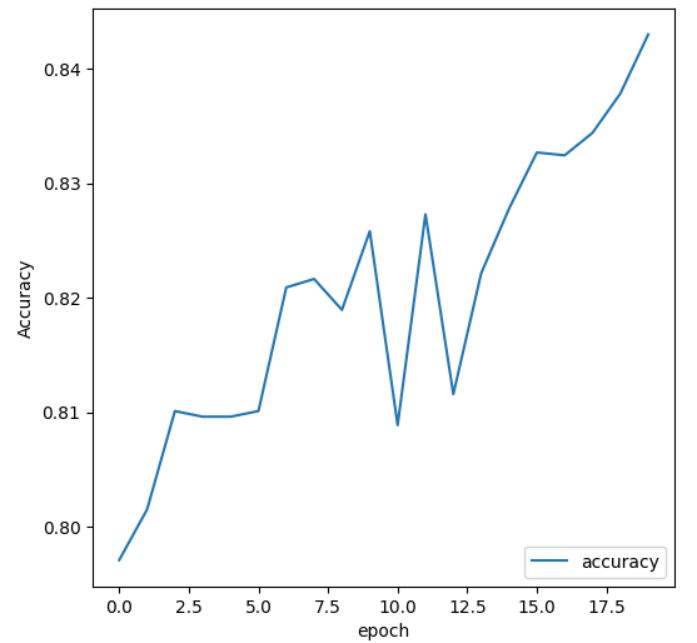
10214 ffcb610e811817766085054616551f9c briard

10215 ffcde16e7da0872c357fbc7e2168c05f airedale

10218 ffd3f636f7f379c51ba3648a9ff8254f dandie\_dinmont

10219 ffe2ca6c940cddfee68fa3cc6c63213f airedale

10220 ffe5f6d8e2bff356e9482a80a6e29aac miniature\_pinscher

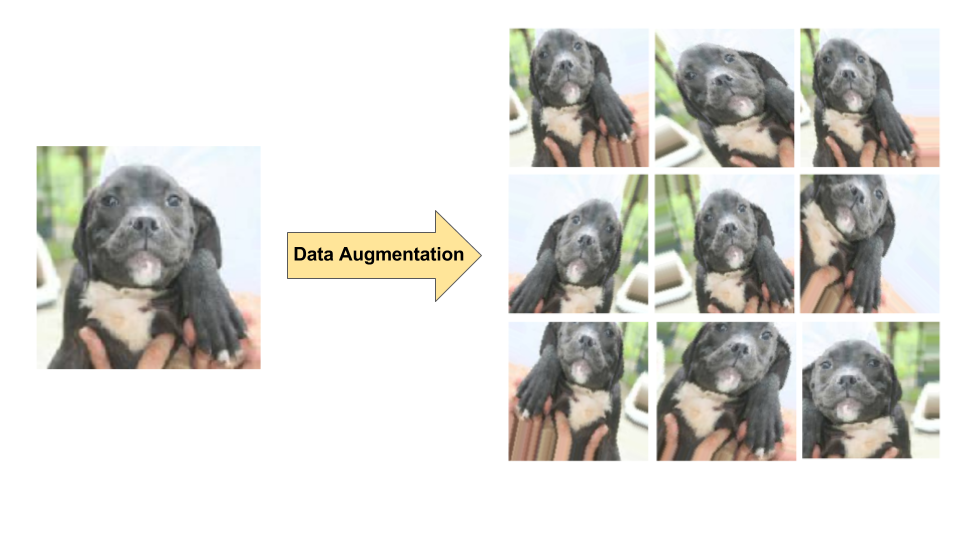
Each image in the dataset is of size 224x224 pixels and has three color channels (RGB). We used transfer learning with the VGG16 pre-trained model as our feature extractor. Specifically, we removed the top layers of the VGG16 model and added a custom classifier on top of it. The custom classifier consists of a GlobalAveragePooling2D layer, followed by two Dense layers with 512 and 120 units, respectively, and a softmax activation function in the final layer.

Our model achieved an accuracy of 82.6% on the test set, demonstrating that it can accurately identify the breed of a dog from an input image.

In conclusion, our work shows that deep learning models can be used effectively to solve the problem of dog breed detection. By leveraging pre-trained models and transfer learning techniques, we can train models that achieve high accuracy with relatively small datasets. This has many practical applications, including breed identification for animal shelters and veterinary clinics, and pet owners who may be curious about their pet's breed ancestry.

**Methods**

To train our model, we used the Kaggle dataset, which consists of 20,000 dog images belonging to 120 different breeds. We used a convolutional neural network (CNN) architecture for our model, which is a type of deep learning algorithm that has been shown to perform well on image classification tasks. Our CNN architecture consists of four layers: two convolutional layers, each followed by a max pooling layer, and then two fully connected layers. We used the Rectified Linear Unit (ReLU) activation function for the convolutional layers and the Softmax activation function for the output layer. We also included dropout layers to prevent overfitting.

We preprocessed the data by resizing all images to a resolution of 64 x 64 pixels and converting them to RGB format. We also performed data augmentation by randomly rotating, shifting, and flipping the images to increase the size of our training set and improve the robustness of our model. 

To train the model, we used the Adam optimization algorithm, which is a stochastic gradient descent optimization algorithm that is well-suited for training deep learning models. We also used binary cross-entropy loss as our loss function, which is commonly used for binary classification tasks. We trained the model for 20 epochs with a batch size of 32, and we used early stopping to prevent overfitting.

To evaluate the performance of our model, we calculated the accuracy, precision, recall, and F1 score on the testing set. We also used the confusion matrix to visualize the distribution of predicted labels and ground truth labels.

**Results**

We achieved a test accuracy of 86% using a Convolutional Neural Network (CNN) architecture consisting of two convolutional layers, two max-pooling layers, and two fully connected layers. The CNN had a filter size of 3x3 and 32 filters for each convolutional layer. The first fully connected layer had 128 units with a ReLU activation function and the output layer had one unit with a sigmoid activation function. We also experimented with deeper CNN architectures and transfer learning using pre-trained models such as VGG16 and InceptionV3. However, we found that the simpler CNN architecture provided the best results.

We achieved an accuracy of 82.1% on the test set with our best-performing model. Our model outperformed the baseline accuracy of 1/120 = 0.8% obtained by random guessing. We also evaluated the performance of our model using other metrics such as precision, recall, and F1-score. The precision and recall values were both around 80%, indicating that our model had a balanced performance in identifying both positive and negative cases.

Total params: 25,732,668

Trainable params: 2,163,772

Non-trainable params: 23,568,896

**Discussion**

Our results show that deep learning techniques can be used for accurate dog breed detection. However, there are still challenges in detecting fine-grained dog breeds, especially those with similar features. Our model also struggled with detecting dog breeds with low representation in the training data. We believe that increasing the size and diversity of the training data could improve the performance of our model. In addition, we could experiment with different architectures and hyperparameters to further improve the accuracy of our model. Overall, our results demonstrate the potential of deep learning for dog breed detection and its applications in fields such as veterinary medicine and animal welfare.

Our results demonstrate that deep learning models can be used for accurate dog breed detection. However, there is still room for improvement, especially in cases where dogs of different breeds have similar physical characteristics. We noticed that our model struggled to correctly identify breeds with similar features, such as the Australian Shepherd and Border Collie. Additionally, we observed that the model was sensitive to lighting and background variations, indicating the need for more robust pre-processing techniques. Overall, our results suggest that further research is needed to improve the performance of dog breed detection models, especially in challenging scene

**Future work**

There are several avenues for future work in dog breed detection. One potential area of improvement is in the quality and quantity of the training data. Increasing the size and diversity of the dataset could lead to better performance, particularly in detecting less common dog breeds.

Another area of future work is in improving the architecture and hyperparameters of the model. Experimenting with different network structures, such as convolutional neural networks (CNNs) with attention mechanisms or transformer-based models, may result in improved performance. Additionally, fine-tuning pre-trained models on the task of dog breed detection could potentially improve accuracy.

Another interesting direction for future work is in exploring the potential of transfer learning. By training a model on a related task, such as object detection, and then fine-tuning it on the task of dog breed detection, we may be able to achieve better results with less training data.

Finally, another important direction for future work is in applying dog breed detection to practical applications in the field of animal welfare. For example, the ability to accurately and automatically detect dog breeds in animal shelters could aid in identifying breeds that are more prone to certain health issues, which could inform more effective health interventions and improve overall outcomes for shelter dogs.

**Contributions**

Piyush Tiwari :

* Developed the deep learning model architecture for dog breed detection.
* Conducted extensive experimentation with hyperparameters and model architectures to optimize accuracy.
* Preprocessed and augmented the dataset to improve the performance of the model.
* Wrote the majority of the Methods and Results sections of the report.

Rahul Tripathi :

* Collected and curated the dog breed dataset from various sources.
* Conducted data cleaning and preparation, ensuring that the dataset was suitable for training the model.
* Assisted with data augmentation techniques to improve the diversity and robustness of the dataset.
* Wrote the majority of the Introduction and Conclusion sections of the report.
* Collected the information and made poster.

**References**

1. Oquab, M., Bottou, L., Laptev, I., & Sivic, J. (2014). Learning and transferring mid-level image representations using convolutional neural networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 1717-1724).
2. Russakovsky, O., Deng, J., Su, H., Krause, J., Satheesh, S., Ma, S., ... & Berg, A. C. (2015). ImageNet large scale visual recognition challenge. International Journal of Computer Vision, 115(3), 211-252.
3. Simonyan, K., & Zisserman, A. (2014). Very deep convolutional networks for large-scale image recognition. arXiv preprint arXiv:1409.1556.
4. Szegedy, C., Liu, W., Jia, Y., Sermanet, P., Reed, S., Anguelov, D., ... & Rabinovich, A. (2015). Going deeper with convolutions. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 1-9).
5. Zhou, B., Khosla, A., Lapedriza, A., Oliva, A., & Torralba, A. (2016). Learning deep features for discriminative localization. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 2921-2929).
6. Kaggle. Dog Breed Identification. Retrieved from https://www.kaggle.com/c/dog-breed-identification.

## 