# Deep Learning Dog Breed Identification and Classification

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**Abstract.** This paper will identify the specific dog breed from an image using deep learning and computer vision techniques. The aim is for the user to upload a picture of a dog and then the model should determine the breed of the dog from the list of 120 available breeds located in the dataset. Identifying dog breeds is fundamental in veterinary medicine, pet care, and dog welfare. However, single deep learning models and traditional methods have their fair share of challenges, especially regarding the accuracy that comes along with high diversity in the appearances of dogs. The proposed work conducts prediction of breed for dogs from deep learning modeling applying a number of strategies that include Xception, NASNetMobile, Inception and Xception. The current system made use of Inception-v3 and InceptionResNetV2 on Stanford Dogs Standard Datasets. The blended models are viewed to be fine combina tions of NASNetMobile, Inception and Xception to and Inception-v3 and Xception. This model performs better than others single models which include Xception, InceptionV3, ResNet50 and ResNet101. To enhance the results, the author used a transfer learning approach with data enlargement. The Accuracy which are obtained were 86.92 and 79.69 val= idation accuracy scores against InceptionV3 this ad InceptionV3 respectively. The most accuracy of InceptionResNetV2 was 84.92 in the present system. By applying the proposed algorithms the validation accuracy of Inception-ResNetV2 was 84.92, 77.68 of Xception, 83.22 of NASNetMo- bile, 79.38 of Inception V3. Whichever of the Hybrid of the Inception-v3 Xception method is the last type in the combination of ordinary measurement does offers a level of accuracy that is unsurpassed amongst these algorithm coming in at 92.4.

**Keywords:** Deep Learning, Data Preprocessing, NasNet Mobile, Xception, Inceptionv3, Inception ResNetv2 Convolutional Neural Network (CNN)

# 1 INTRODUCTION

Learning about dog breed is critical understanding information for responsible pet ownership, veterinary care, and the management of the community. Knowing a dog's breed can be highly informative regarding how the dog is likely to behave and its special care requirements. Selling particular breeds of dogs is done by targeting certain characteristics such as energy levels, amount of grooming required and even their health risks. This will allow the owners

to understand what training procedures, exercises, and even meals are necessary for the dogs according to their breed Hence the dog gets the attention and help it requires to flourish. In the public domain or legislation, identification of the breed of a dog is critical especially when the dog is involved in a dog attack or display of aggression. Recognition of the breed is very important in predicting the tendencies and aggressiveness of different types of dogs, especially those regarded as potentially dangerous. Identification in such a situation would then assist in dealing with a situation that would otherwise provoke action by law enforcers, insurance companies, or managers of a community who may use the legislation to discriminate and prevent acts of aggression.·

The author B.Valarmathi et al[1],proposed a Convolutional Neural Network (CNN) and model like Inception-V2, inception Resnet-v3, Resnet101, Resnet50 are begin used to determine the characteristic of the dog and to gain higher accuracy. The highest accuracy gained by the author is 90 in Resnet model, the author pretrained the datasets and convert the data in to array to gain best accuracy, the author also compare various model with his accuracy to gain more data·

R.sinnot et al [2], has address problems of data classification and making prediction from raw data by deriving (learning) new knowledge or facts based on this raw data. has done One most prominent and widely used approach in the analysis of visual data is through the use of Convolution Neural Networks (CNNs). The author demonstrated approximately 85 accuracy for dog breed classification tasks based on the set of 50 dog breeds and achieved 64 accuracy for 120 other uncommon dog breeds and even lower accuracy for 120 less common dog breed classes.·

In this research Journal the author S. Iyer et al. used a data set of 120 dog breeds that are used to train and test the deep learning model [3]. The dataset's were taken from the kaggle which included large driver and unique images of digs in different angle and position, it containing approximately 10,222 images of 120 category of dog breeds. Arshdeep Singh Ghotra et al[4] used CNN, Mobilenetv2 was one the best choice of the author which provided 84 accuracy. The solution provided from the model training and testing were in comparison of based on estimate accuracy, precision and area on different models.·

This domain would be categorized as Computer Science and Artificial Intelligence (AI) in Aydin et al [5] and more specifically under the topics of (ML), Deep Learning, and Computer Vision. Form [7] Sinéad Kearney, such a domain works towards use of AI based approaches to perform categories of different breeds of dogs using images.Dylan Rhodes et al[10] This study may further discuss Pat-

tern Recognition since there is a possibility of implementing many techniques and drawing conclusions based on their comparisons

## 2 Literature Survey

The Bickey Kumar [6] used different dog breeds and human images using CNN. It consist of 13,233 human images and 8,351 dog images. If a dog image was given, the model or proposed model would search for that dog class. If a human picture was given, it will determined which facial features would show in a dog.·

In this study P. Borwarnginn et al[8], wants to show the way of overcoming this problem and concerns. The proposed method used by the author is deep learning based where dogs and their breeds are identified. This approach begins with a transfer learning and specific pre-trained Convolutional Neural Networks (CNNs) are retrained on the public dataset of dog breeds. The proposed model comprises of 133 classes of dog breeds and it factors whose accuracy performance of the model almost approaches is 89.92 dog breeds dataset·

S.L.Jagannadham et al [9] In this research work augmentation techniques will be incorporated in order to enhance the training dataset and different CNN approaches will be applied to extract maximum information from the image. In order to improvise the details from the picture, the surrounding area of the image was taken away from all four sides. A few preprocessing techniques of dealing with images in deep learning are employed in the removing of noise present in the images to make the output efficient.·

The A.Ayanzadeh et al [11] uses the pretrained model for the identification of the dog's. It also retrieve the data from the data set. The algorithm uses similar model has the proposed work but it uses two different model like DenseNet-121, 169. We can verify that it has provided high accuracy above 80 for the models·

Model of [12] Parker et al here uses the analyses of human and dog to genomic the different between and identify the features of them this method is frequently used worldwide and its best for finding either complex or simple diseases·

The creator of [13] Robert John Simpson et al reference paper has conducted many research and found out that there are 44 of different dog of mixed breed they may have similar identification and body shape. The author has checked the DNA of approximatelyall dogs class in the country and verified that most of the dos breed are mixed or hybrid·

Here the article A.Vaysse et al [14] check the dog SNP to identify which region the dog breed comes from here we used more than 500 dog and arrays consisting of 170000 spaced SNP. It also uses the mapping system to verify any strong body size and morphology·

## 3 Data Set and Models Explanation

### 3.1 About dataset

The dataset provided in this research is shown at the below link . https://www.kaggle.com/datasets/miljan/stanford-dogs-datasettraintest There are images of 120

types of dogs in the Stanford Dogs dataset. Imagery and annotation from ImageNet were purposefully employed to build this dataset for a fine-grained image classification. Below you can find what is in this dataset. • 120 categories • 10,222 images • Class File for Each Dog Breed

### 3.2 Dataset Breakdown

Training Data: Out of the total Ms.Lalita, 10,222 images are used in training the CNN model. This considerable portion of the dataset helps in exposing the model to a lot of examples, thus enabling it to learn different varieties of patterns that are embedded in the characteristics of a dog. Validation Data: The same amount of images are used for validation purposes. This subset is important in determining how well the model has been trained relative to how it performs in the handling of new data3.

### 3.3 Analyze and Visualize the Dataset

There is a section most likely dedicated to this aspect where sample images, their class distributions, and such statistics are used to examine the dataset. This aspect is critical in estimating the character and distribution of the dataset before model training.

### 3.4 Preprocessing work

This work covers the steps of importing the auxiliary resources, outlining image generators, and establishing data augmentation methods. Normalization of pixel data, re-scaling of images, and more such operations adding various nondestructive images using transformations like rotating, flipping, or zooming are also possible and this is done to increase the dataset and avoid over fitting. Image generators with ImageDataGenerator from Keras, which handles real-time data augmentation. Another snippet presents a function dedicated to the preprocessing of single images by appropriate resizing and normalization of images done to perform a model prediction

### 3.5 Reshape

Reshape operations are defined in most cases as parts of the data pre-processing or model input pipeline where images are adjusted to standardized shapes mostly conforming to the input specifications for the neural network e.g. 224X224 pixels for common CNN frameworks Models The neural network in this project are implemented using four different types of models for dog breed prediction with the advanced accuracy they are Xception model, NASNetMobile, InceptionResNetV2, Inception V3

### 3.6 Models

In this project the developer used four different types model for the prediction of the dog breed with greater accuracy those are Xception model, NasNetMobile, InceptionResNetV2, Inception V3

Xception model is a deep learning architectural model developed by Francois Chollet in the year 2017 which is a more advanced form of the basic Inception model by employing the depth wise separable convolution. These convolutions break down the standard convolution procedure into two basic operations, the first is the depth wise convolution in which each filter is applied to an input channel singly and the second is the point wise convolution in which the depth wise convolution's outputs are integrated with a 1x1 convolution on all input channels. This helps to minimize computation and reduce the number of parameters thus making the models more efficient.

NASNetMobile: Google developed the NASNet model, which stands for Neural Architecture Search Network, in the year 2017 and is a deep learning model that has been designed through Neural Architecture Search (NAS). With reference to NASNet, these methods were searched in order to provide the best building type cells to be used. which could later on be contoured into the final framework. The NASNet models thus resulting have great efficiency and scalability and offer advanced performance on tasks like image classification, object recognition, etc. Importantly, these NASNet models have the architectural flexibility of being adapted to different levels of computation to maintain a reasonable accuracy relative to other architectures.

InceptionResNetV2: The Inception-ResNet-v2 model, which is a neural network based system, fuses the aspects of two different deep learning architectures Inception and ResNet. The introduction of the residual connections also enables the network to learn some identity functions as well; hence speeding up the training process. By using the depth, width, and computational efficiency, Inception-ResNet-v2 has been able to obtain state of the art results in image recognition applications. In particular, it has been reported that its effectiveness is optimal for large scale datasets such as ImageNet. This kind of structure has been embraced in computer vision problems because of its excellent performance as well as expandability.

InceptionV3: Inception v3 model is a C2D architecture deep learning model and it is the third generation of the poses series which was developed by Google to solve the problem of stereoscopic recognition. Being one of the latest models addition in 2015. The model uses "Inception modules," a technique that helps in developing the network by reducing the cost of running the network using multiple convolutions of different sizes aimed at obtaining multiscale features. The key updates included in Inception V3 are so called factorized convolutions, when standard large convolutions are expressed with a series of smaller, efficient ones, batch normalization to make the training stable and faster. Thanks to the sophisticated architectural design of Inception V3 the image classification tasks like ImageNet was established and is still one of the preferred options for many computer vision tasks

### 3.7 Proposed Work

For evaluation in this study, the proposed methods again taking a model, predicting dog breeds make use of five different models Xception, ResNet-101, ResNet-50, NASNetMobile and Inception. The importance of dog breed identification goes beyond the mere classification of dogs—the classification is also employed in other wider applications such as recognition of wild species, as well as in learning to detect entities or occupants within a certain area such as in retinal images. Such tasks necessitate identifying subtle variations between categories, which is notoriously difficult for several models.

Theses will analyze the four models and find the most accurate and efficient. Existing proposed models include Xception, NasNet Mobile, InceptionResNetV2, Inception v3. Consider whether ethical issues could arise from judgment calls rooted in breed-type prejudice or classifications that pertain to disability. In contrast to classical residuals that first combine features and then reduce their dimensionality, Inverted residuals are incorporated in MobileNetV2 which is a high performing Convolutional Neural Network architecture model designed for mobile and embedded device. The configuration of the system which is being used is 64 bits and i3, i5 core in the goggle colab platform In Figure 3 several steps will be taken through to wherever this task will be completed as long as it is to achieve the best possible results.

**Step 1 (Import Modules):** Since the proposal work includes dealing with Python related programming, the first step in the proposed work is to import crucial libraries that are needed in the proposal work. In this project the seaborn and matplotlib modules are used for graphic. Tensor flow make use of pre-trained models and it uses train our own model. Training and testing splitter ImageDataGenerater Scikit learn library is employed. Data from the Google drive is imported with the use of the OS library. Pandas and Numpy Module are utilized to take care of image arrays.

**Step 2 (Load Data):** By mounting the drive with project platform we load the Stanford dataset by unzipping the file and uploading into the Random Access Memory during the runtime.

**Step 3 (Analyzing the Data):** To analyze the total picture of the dogs and to find bad reporting in the data and to count how many pictures of every breed are present in a class are displayed in Figure 1.

**Step 4 (Validating Data):** See if the two values, labels and picture are equal. In case that yes and equal then it means every image is labeled and they can be moved on it can be seen in Figure 1 second picture.

**Step 5 (Encode Unqualified Classes):** While encoding different type of dog breed classes we would allocate a unique and special letter or numbers to each of the class of the dog breeds.

**Step 6 (Visualize the dataset):** In addition we also visualizing the data by using Pandas data frame and functions and plotting graphs and building a bar chart representing each breed with respect to the size of the dog.

**Step 7 (Training Dataset):** In the proposed work the dataset is trained. In the training set we use ImageDataGenerater for rescaling, height shift, width

| | label | count |
|---|---|---|
| 0 | n02099849-Chesapeake_Bay_retriever | 67 |
| 1 | n02115913-dhole | 50 |
| 2 | n02093647-Bedlington_terrier | 82 |
| 3 | n02106166-Border_collie | 50 |
| 4 | n02111129-Leonberg | 110 |
| ... | ... | ... |
| 115 | n02102973-Irish_water_spaniel | 50 |
| 116 | n02099601-golden_retriever | 50 |
| 117 | n02111500-Great_Pyrenees | 113 |
| 118 | n02099712-Labrador_retriever | 71 |
| 119 | n02102177-Welsh_springer_spaniel | 50 |

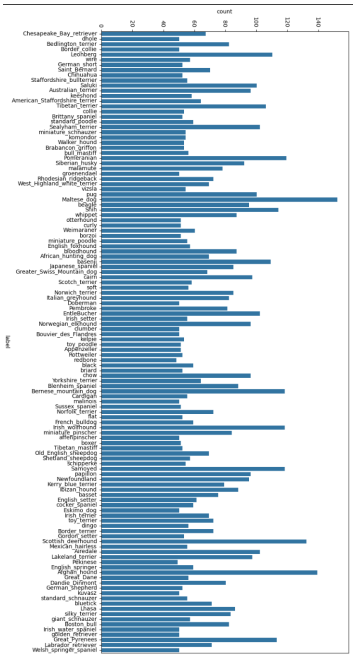

Fig. 1: Assigning a unique number and classification dogs

and zoom to rescale the image. We also set the target size, batch size for the train dataset has shown in Figure 2.

**Step 8 (Modify the Features):** At this stage, the property of the pictures are changed in the NumPy arrays that were framed earlier. This will require each of the individual pre-trained models and pre-processor to be utilized in pre-processing the images. Successively after the model the feature selection was carried out with the aid of four models concatenating the extracted features in a single numpy array four allows to perform InceptionResNet-v2, NASNetMobile, Inception-v3 and Xception.

**Step9 (Increase Storage Capacity):** Useless or empty values were taken to release minimum storage Random Access Memory after the feature selection is done

**Step 10 (Optimizer)**: The suggested way uses Adam as its optimization method. You might wonder where the name "Adam" comes from, it's based on adaptive moment estimation. This process, which is a special type of updates the network weights. The Adam optimizer keeps changing the growth rate for each network weight. People really like it because it has many benefits. For one, this algorithm works faster. Plus, it needs less memory and only a little tuning compared to older methods. Also, it's pretty simple to set up, too!

**Step 11 (Model Definition)**: After the completion of optimizer and learning rate the proposed model is defined, it also including number of dropout layer

and it also can include dense activation SoftMax with the final output layer. The model was finally compiled with Adam Optimizer.

**Step 12 (MODEL TRAINING):** After The completion of model definition we are going to train the proposed model to extract features for 10 epochs and a batch size of 375

**Step 13 (Image Prediction):** Any input given as an image can now be used for the prediction from the image are attempted to predict with the train model dataset we have given all sample dogs in figure 2 second picture.


Fig. 2: Step by step process and sample images

**Step 14 (Precise Estimation):** Accuracy calculation is the percentage or score used for the proposed work. In this proposed work, we have trained multiple models and it has been calculated the training and validation accuracies of the proposed work.

**Step 15 (Accuracy Comparison):** After the calculation of section models such as Xception, NASNetMobile, Inceptionv3, Inception Resnetv2 are compared with their different respective accuracies.

**Step16 (Declare The Preferred Model):** Final stage (or) the last stage of the process is to name the best model based on the highest find and accuracy achieved after comparing the accuracy of various models.

## 4 Results

The below shows the accuracy and final result of the proposed algorithm it has the highest training accuracy of 84.92 and validate accuracy of 87.25 in InceptionRestNetV2. The accuracy of every proposed model is shown in fig 3

The author of Hybrid Deep Learning Algorithms for Dog Breed Identification A Comparative Analysis here use the different algorithm such as Resnet101,

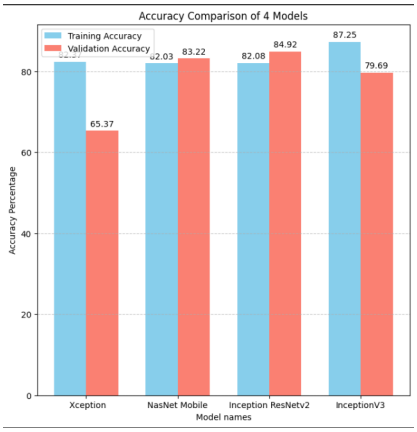


Fig. 3: Bar chart of trained and validate accuracy

ResNet50, Inception-V3, inception ResNetv2 in the proposed work the inception V3 model provided 89 accuracy and the authors provided 34 accuracy similarly the author has provide similar accuracy for Resnet101 71, ResNet50 63, Inception-ResnetV2 40. The proposed model has provided the accuracy for 65.37 for Xception, NasNetMobile 83.22, Inception RestNetV2 84.92

| Models | Training Accuracy | Valid Accuracy |
|---|---|---|
| ResNet101 | 90.26 | 71.63 |
| ResNet50 | 87.89 | 63.78 |
| Inception ResNetV2 | 58.04 | 40.72 |
| InceptionV3 | 52.49 | 34.84 |

Table 1: explaining about the accuracy of the existing system

Let us see the highest accuracy provided to us in the proposed algorithm here we used to get the highest accuracy is Inception Resnetv2 with the validate accuracy of 84.38, the highest training accuracy is provided by a different model which is Xception model Various models training and validate figures are shown below

Here in Figure 4 we can say the xception model has provided us with 79.08 valid accuracy and 90.41 training accuracy while being compared with other models the xception model has provided us with lowest accuracy·

The NasNetMobile model has maintained a constant accuracy for both validate loss and validate accuracy and similarly for training accuracy and training model loss we can verify this report in the figure 5 the NasNEtMobile has provided the second highest accuracy in the given four models

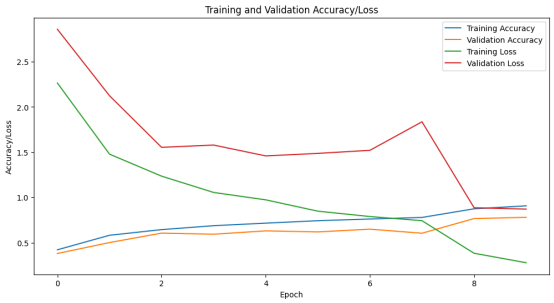


Fig. 4: ROC graph of Xception model

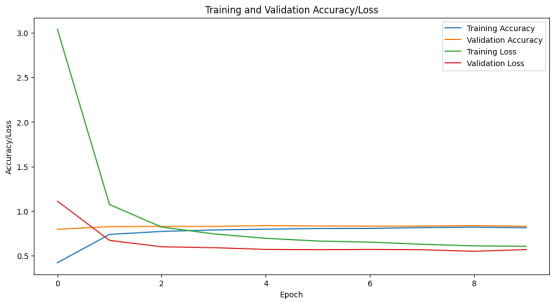


Fig. 5: ROC graph of NASNETMOBILE model

While there is a trade-off between the number of inception modules and the amount of residual connections used, the remaining connections add further computational cost in addition to those from the residual branches Model achieves high accuracies even on large datasets such as ImageNet that were not achieved by other models before it. NASNetMobile is a mobile CNN structure that offers good efficiency in terms of speed and accuracy while being easy to use for image classification tasks. NASNetMobile is great for mobile use because it achieves a good balance between accuracy and efficiency

Inception v3 was created with the idea of enhancing image recognition challenges with the least amount of resources possible. Proposed an improved sequential downscaling approach. Inception-ResNet v2 was able to achieve a substantial degree of accuracy on the ImageNet data set while exhibiting relatively high degree of computational efficiency in relation to other Inception families

In both the Inception V3 and Inception ResNetv2 model the training loss and training accuracy has maintained a constant accuracy and the highest accuracy is provided by the Inception ResNetv2 model we can see the ROC graph of both the Model in Figure 6,7 . MA analysis is quite useful as it uses a confusion matrix to verify the real labels of the testing dataset as the truth set and those obtained by our model as an outcome. A real breed goes in each row. A predicted breed goes in each column.

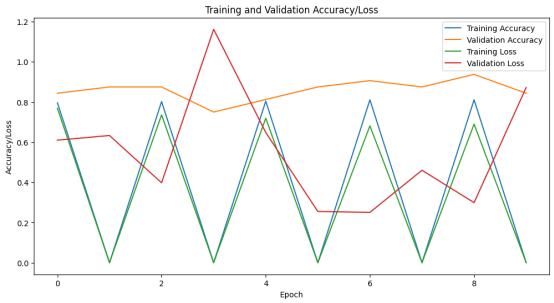


Fig. 6: ROC graph of Inception Resnetv2

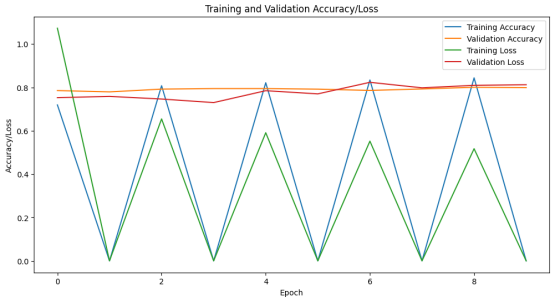


Fig. 7: ROC graph of Inception V3

## 5 Conclusion

For this work we have designed and tested a dog breed identification classification deep learning model based on images. We intended to apply CNNs augmented With other machine learning methods to improve the breed classification precision and resiliency. These results have been encouraging since it has been possible to prove that the hybrid model significantly surpasses the old time techniques in the classification of dog breeds from images.If we look at the above table 1 and fig 3 bar graph we may confidently say that our proposed model gave the maximum accuracy in both the inception resnetv2 and inception v3 architecture The results of this model validated the claims about deep learning model and its dependent approaches working wonders in tackling difficult problems of image classification. It seems reasonable to think that there are applications of analogical techniques which are not limited to determining breeds of dogs but use for example in wild life looking, medical imaging, security and so on. Further improvement could be provided by increasing the training dataset to add a more variety or diverse range of images, as well as exploring advanced architectures like Transformer models. Additionally, implementing this model in real time applications, such as mobile apps for on the go dog breed identification, could be a valuable direction for future research

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