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Dog Breed Identification using ResNet Model

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Abstract—As dogs are domestic animals due to the many numbers of dog breeds available around the world. It's hard to find out the exact dog breed name for a common person. There are many techniques available to identify dog breed. But the proposed work introduced the new technique called RESNET which is the part of CNN to classify dog. RESNET is used to identify images. It helps to perform different tasks on larger datasets. Identification of different dogs is one of the important applications of Convolutional Neural networks. Since the identification of dog breeds is very difficult because they spread in a large number and it makes very hard for a person to identify or classify dogs. With the help of Keras and TensorFlow, a dataset is created, tested, and trained for the detection of dog breeds by using RESNET. Around 120 different dog breeds are present in the dataset which consist of 20600 images of dogs. From this paper, load these images and convert them into a NumPy array and normalize them. Then,100 epochs were used with a batch size of 128 to achieve the best accuracy. The model is saved for further process to create a web application to identify the dog.

Keywords-Convolutional Neural Networks, ResNet, Keras, TensorFlow, NumPy.

I. INTRODUCTION

In recent years, Deep learning(Li, Wenmei; Liu, Haiyan; Wang, Yu; Li, Zhuangzhuang; Jia, Yan; Gui, Guan, 2019)has been focused on many fields, such as image processing and natural language process. Particularly Convolutional Neural Networks (CNN) increased high accuracy in the image processing field. This Convolutional Neural Network has become most famous for image recognition problems. CNN differs from other classification problems in that it begins with raw data and then applies the modeling technique. CNN works like human vision, firstly we can classify things using the vision. We can present CNN in the form of an algorithm by building a mathematical model. Convolutional neural networks are effective in analyzing visual imagination. They use multi-layer perceptron and require as many layers to pre-process the model. CNN has at least one fully connected layer preceded by the desired number of fully Convolutional layers as a standard multi-layered network. One of the benefits of CNN is that it is translation invariant, also called shift invariant.

Dogs are considered to be man's best friend and they act as the best pet. They can be easily trained and used as service dogs to help handicapped persons and guide them. They are also used for military purposes. There were almost 350 dog breeds all over the world. They require care, food, and a habitat environment depending on the breed and for this reason, we are going to identify the breed of the dog. The proposed paper is to identify various breeds of different dogs. The dataset was taken from Kaggle: Dog Breed Identification. There were around 20,600 images of dogs. The dataset was divided into two parts for training and testing. Since the dataset is too large, the implementation of Keras and TensorFlow takes place. Keras is the model which provides a way to define the complete graph. Many layers can be added to the graph to build the network as per their conditions. TensorFlow is also one of the fastest-growing libraries in deep

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learning. Both libraries are helpful for quickly building the model and training the neural networks.

II. LITERATURE SURVEY

This problem statement has been extensively studied over the past 5 years by researchers and automotive companies in a bid to create a solution, and all their solutions vary from analyzing the Dog breed identification using different methods, some of the research was as follows.

The work of (Mulligan, K. and Rivas, P., 2019) in the year 2019, July, conducted dog breed identification with the help of Xception Convolutional Neural Network architecture. This paper is mainly focused on classification tools. The dataset is downloaded from Kaggle. This classification is worked on CNN and Xception with multilayer perceptron. The methods used for Xception and MLP. Experimented on 120 unique breeds, over 10,200 images of dogs. From this paper, a confusion matrix was created over training and test set. Its major drawbacks were generating a diagonal pattern and the values incorrectly predicted. The methods were not passed through cross-validation. Achieved accuracy of 54.80 %. Later, with the performance matrix, changing and increasing the number of splits utilized by both LogLoss and balance accuracy. After doing this, achieved the correct prediction of describing the image belonging to which type of breed.

The work performed by (Shi, Wenting, Jiaquan Chen, Muyun Liu, and Fangyu Liu.,, 2018). in the year 2018 mostly focused on pattern recognition of which object belongs. This paper is based on image or pattern recognition of identifying the dog's breed. Four models were used in this paper such as ResNet18, VGG16, DenseNet161, and AlexNet. Data Augmentation was used to increase the number of training data parameters. Conducted some experiments by using Data Augmentation, Transfer Learning, Stochastic Gradient Descent (SGD), Adaptive Moment Estimation (Adam), and parameter tuning. By comparing the four models, Densenet161 gives the best accuracy. Comparing Loss Analysis, and Accuracy Analysis by designing a model using 50 epochs achieved an accuracy of 82.36% from the Densenet161 model. The major drawback is by using VGG16, overfitting occurs.

In this research paper, (Z. Ráduly, C. Sulyok, Z. Vadászi and A. Zölde,, 2018).in the year 2018 implement a fine-grained image recognition problem. Used multiclass classification, Inception ResNetv2, mobile trained model. The dataset is taken from the Stanford dog dataset. The training data is split into train and validation folds. Fine-tuning and 5 – fold cross-validation were also used in this paper. This paper consists of various experiments in CNN architectures, Data Augmentation, Learning and hyperparameters, and Frozen graphs. Accuracy, precision, recall, and confusion matrices were used to predict the accuracy of different methods and take the best one. Used one of the software called "sniff" for the prediction of trained Convolutional neural networks. Two different CNN architectures were used in this paper. One is NASNETA mobile architecture and Inception ResNet v2 deep architecture. By using Inception ResNetv2, we get an accuracy of 90.69%.

(B. Vijaya Kumar, K. Bhavya.,, 2019). focused on fine-tuning pre-trained models in the year 2019. This paper was implemented by using Image classification, transfer learning, Convolutional Neural Networks, Vgg16, Xception, and Inception V3. Finally, a multi-class classifier named logistic regression was used to identify the breed of the dog. The major drawback is by using CNN we need to have a large amount of dataset and images, to reduce this drawback they used transfer learning to train the model to provide the best solution for this. The results that are produced by transfer learning are better than the results produced by Inception v3. Because a Multinomial linear classifier was applied to pre-train the model in transfer learning. From this paper, we can conclude that Convolutional neural networks with transfer learning provide a very better solution for different image classifications. But in this type of paper when there is a need to rebuild the paper from scratch it is difficult to start because it requires a lot of time and cost by using CNN, so we use transfer learning.

(Watabe Hiroki and Hiroshi Watanabe., " , 2017) in the year 2017 implemented CNN by using Data Augmentation and Discriminative Generative Adversarial Network (DCGAN). Proposed Data Augmentation is more effective when compared to standard Augmentation. The major drawback is it generates both realistic and unrealistic images. The proposed approach was to apply DCGAN to CNN Data Augmentation. DCGAN has both a generator and a discriminator to create images. From this method, we can generate many more images and increase the efficiency of the CNN model. Using this model, we can achieve an accuracy of 82.7%.

The work done by Thaha Mohammad S.Y, Subhash Chandar T.J, and VaidhyaG.K (Tejeswar Sadanandan et al,,, 2020) in the year 2020 was to identify the dog breed using different pre-trained models. CNN uses transfer learning with the help of ResNet50. OpenCV implementation is used to detect the faces of dogs as well as humans. This process is executed on different systems such as CPU, GPU, and OS in the computer. This paper deals to identify the human face also with the matching pattern of the dog. Haar Cascade feature is an OpenCV method used to identify objects. This feature helps to identify how much percentage of humans and dogs are predicted. It gives an accuracy of 82.7%.

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This paper is presented by (A. Varshney, A. Katiyar, A. K. Singh and S. S. Chauhan,, 2021) in the year 2021 to identify the dog by using different models such as InceptionV3 and VGG16. As the dataset was taken from Stanford. This dataset contains nearly 40 thousand files with dog images. Data preprocessing is done for the CSV dataset and then Data Augmentation is applied to it. This data augmentation is done to remove or clean the overfitting presented in it. After data augmentation, it is compared with two different models such as InceptionV3 and VGG16. When compared with these two both gives good accuracy and we compare both train and validation accuracy. For good accuracy, the batch size was changed to 12 and the number of epochs was increased. InceptionV3 has the highest accuracy when compared to VGG16 and its accuracy is 85%.

The work done by (Kanika Gupta, Sharankhala Goel, Bhavya Aggarwal, and Riya Gupta,, 2020) by using the Keras library with different Inception models. This paper studies CNN architecture and its different layers in it such as ReLU, Convolution, and Pooling. InceptionV3 and InceptionResnet V2 were the two models used in the process. Pytorch is another method that is used. With Keras and tensor flow translation of pictures happened. Train and Val accuracy are predicted from this and a graphical model is drawn to identify the difference. The losses were also compared in this paper. To train the model 10 epochs were used. Many improvements were needed for this paper. As the accuracy was also low.

(Whitney LaRow, Brian Mittl, Vijay Singh, , 2020)used machine learning techniques to identify the name of the dog from the images. They used to identify the dog with the help of facial key points. SIFT descriptors are the features extracted from facial key points. This paper deals with fine-grained classification. As per the paper firstly a CNN model is trained and facial key points like ears, eyes, nose, legs, and teeth are used to identify the images of the dog. GrayScale SIFT descriptors were used to compare the image key points with other image key points. OpenCV was used to identify the facial key points in it. RGB histogram was also a feature extracted from the facial key points. Different machine learning algorithms were implemented such as Support Vector Machine, Logistic Regression, and KNN. We can able to guess the dog breed over 50% only. By facial key points in the form of pixels, further work can be developed.

III. EXISTING WORK

The paper is from Dr. Kanika Gupta, Sharankhala Goel, Bhavya Aggarwal, and Riya Gupta. This paper deals with the study of Convolutional neural networks with the help of Keras and TensorFlow and applying different models such as InceptionV3 and Inception ResNetV2. This paper aims to study different layers present in the CNN model such as Convolution, ReLU, and pooling layer. As this is image classification problem different algorithms were used to improve the accuracy of the model.

The dataset was downloaded from Stanford Dogs set. There were around 120 different types of dog breeds and 20,000 images of dogs which includes both training and testing images. Transfer Learning is used to build the model. Keras, TensorFlow, and PyTorch are the different libraries used to build the model. The images are preprocessed and the n Data Augmentation is done to reduce the size of the pixels. The augmentation is done by Zooming, rescaling, flipping, and shifting. By doing all these overfitting occurrences will be reduced. Now applying different models such as InceptionResNETV2 and InceptionV3. Then the comparison of accuracies was shown in a graphical format. The loss table of validation and test was also shown in graphical format. InceptionV3 gives good accuracy when compared with InceptionResNetV3.

IV. PROPOSED METHOD

The proposed method deals with the study of Convolutional Neural Networks architecture and its layers. As the CNN model is about different types of layers such as the convolution Layer, pooling, and fully connected layer. As this CNN model is the most important model for image classification in deep learning.

A convolutional neural network or CNN is a fascinating topic and it has many real-world and highly useful applications, such as self-driving cars, facial recognition, object detection, and motion or movement detection, etc., Neural networks are the main building blocks of deep learning and the convolutional neural networks are situated on top of it. The main idea behind the convolutional neural network is using filters. The filters are responsible for detecting objects or images. These filters are also useful to detect the edges around the image. These edges will be passed to the next layer to detect the ears, eyes, nose, etc. and on further layers, the image can be identified. After combining all the layers into a particular layer, we can identify whether it is a person (or) object (or) animal. The CNN becomes more complex and identifies all of the image's components. CNN is made up of three main layers, which are as follows:

A. Convolutional Layer:

The convolutional layer is the starting layer of CNN. It is the primary structural component and it acts as the heart of convolutional neural networks. This layer is responsible for identifying the edges and features of the images. This layer is the main reason for the good performance of CNN. In a single convolutional layer, we use many filters and different filters

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help to detect different features in a picture, such as detecting horizontal edge, vertical edge, circle, etc.,

For identifying a grayscale or black and white image we have a formula that is (n*n*1) * (f*f*c) = (n-f+1) * (n-f+1) * c, for this if we use c number of edges then we get c number of images in the output of the proposed work. When the operation is done on a colored image, we have different formula as (n*n*3) * (f*f*3) = (n-f+1) * (n-f+1) * 1, in this, for a colored image we are having three channels as red, green, and blue, for this image a 3-dimensional cube (a filter of 3 channels). In this after superimposing we will get a single image as an output.

For example, a size of 6x6 with different numbers in each pixel and also a filter of size 3x3 pixel is multiplied then the resultant matrix would be 4x4. The values of the 4x4 matrix are obtained by superimposing a 3x3 filter with a 6x6 pixel.

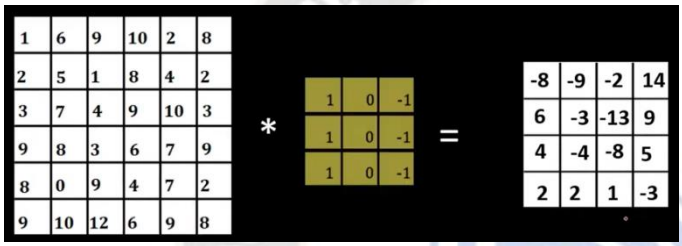

Figure 1. Convolutional operation

B. Pooling Layer:

Similar to the convolutional layer pooling is responsible for dimensionality reduction. For performing this pooling layer we need to fix a particular size from a matrix and a stride need to be taken with a particular amount then the output will be an image with the same size of the filter as well as stride. This layer helps extract the maximum values from a filter. This is done to reduce the image size as well as computational cost. This pooling layer is applied after the convolutional layer. No parameters were involved in this layer. There will be the same number of inputs as well as outputs. There are two types of pooling they are:

- Max pooling: This method is the most commonly used in this filter with the maximum value taken and send to the output matrix.
- Average pooling: This method is less preferred when compared with Max pooling. In this, the average of each filter is taken and sent to the output matrix.

C. Fully Connected Layer:

Fully connected layers are used to classify the features. It will decide whether the image present in it is a human or animal or an object. The fully connected layer is a dense network of neurons connected to every neuron in the next layer as well as the previous layer. After the extraction of features from the convolutional layer and pooling layer, the final features are obtained as output and these features are created as a one-dimensional array. This one-dimensional array is obtained with the help of a flattened array. As there will be three fully connected layers, the one-dimensional array is taken as an input and passes through them and when it reaches the third fully connected layer it uses the SoftMax activation function to classify the image into a particular category.

D. Design of Proposed System:

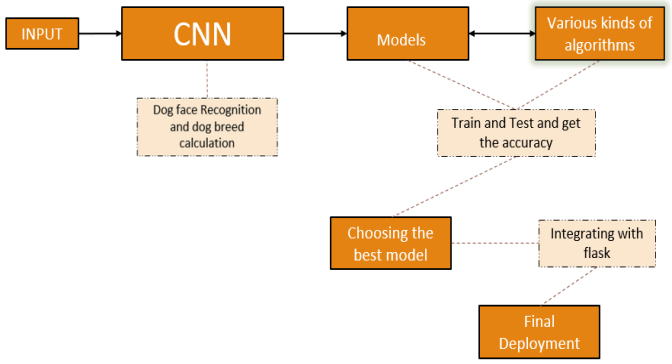

Figure 2. System Architecture

This is the overall system architecture. In this, the Dog images are recognized and calculated by using the CNN model. Different types of layers were studied in the CNN model and a CNN model is built to find the dog breed. Here different algorithms were implemented such as the ResNet, and InceptionV3. Every algorithm was implemented on the CNN model and after the implementation, we test and train the model and predict the accuracy. In these three models were tested and the model which gets good accuracy will be taken as the best model. This model is integrated with the flask application to create a web application and then used to identify the dog breed.

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V. IMPLEMENTATION

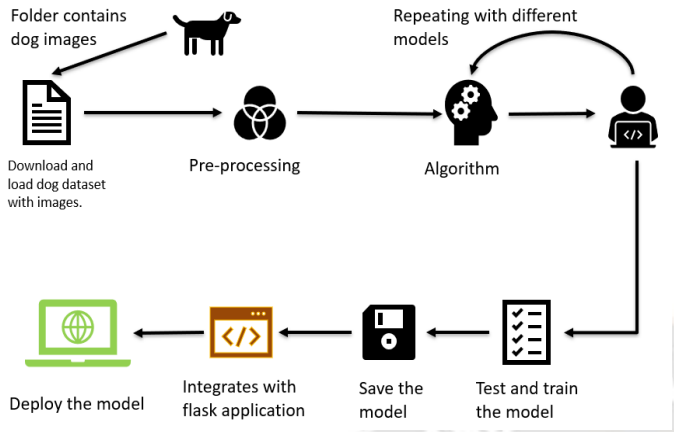

Figure 3. Flow Diagram

A. Dataset:

For every paper, a dataset is compulsory to attain good results. This dataset contains one CSV file and around 20,400 images of different dogs images which include both training and testing images. There were around 133 different types of dog breeds. This dataset was downloaded from Kaggle. Kaggle is a platform where there will be many datasets available in this. These datasets were used to build the models in machine learning as well as in deep learning.

B. Data Pre-Processing:

In the preprocessing, necessary libraries were imported such as NumPy, pandas, matplotlib, Keras, and TensorFlow. Collected dataset consists of one CSV file and for it, we check the shape and records and then count the number of breeds present in the CSV file. One hot encoding is used to convert numerical categorical values into binary vectors. Images present in the dataset are normalized. Normalization is the process of modifying the range of pixel intensity values. Here we create a NumPy matrix and convert images to a NumPy array and normalize them. This normalization helps to reduce overfitting.

C. Building CNN model:

Here CNN model is created using Keras and TensorFlow. This CNN model talks more about image classification and this CNN technology has increased a lot for images. This CNN model combines with different models and gets good accuracy. CNN recognizes dog facial key points in images and identifies the breed of the dog. This paper is used to create, train and test the convolutional neural networks model with the help of Keras and TensorFlow, which are helpful for the detection of dog breeds in the paper.

D. Algorithms:

Different algorithms or models are used with convolutional Neural Networks for better accuracy and efficiency. The models are:

i. ResNet50
ii. Inception V3

ResNet50 Architecture:

This is also the best Convolutional Neural network-based deep learning networking model. A residual network is an artificial neural network that makes the model skip layers without affecting performance. This network is 34-layer plain network architecture. Kaiming He, Xiangyu Zhang, Shaoqing Ren, and Jian Sun founded this network in 2015. Some extra layers will be added for better accuracy and performance while a complex problem is being solved. This model can be used as an art and image classification model.

Inception V3 Model:

This is also the best convolutional Neural network-based deep learning networking model. In 2015, This inceptionV3 method was introduced. This model has 42 layers in total and the error rate produced in this model is lower than its predecessors. InceptionV3 is the updated version of InceptionV1 and InceptionV2. The following are some of the modifications that can be made to the InceptionV3 model:

i. Factorization into smaller Convolutors.
ii. Spatial Factorization into Asymmetric Convolutions.
iii. Utility of Auxiliary Classifiers.
iv. Efficient reduction of grid size.

VI. RESULTS AND DISCUSSION

The given dataset is split into training and then testing, here the training dataset is split into training and validation and training the model with 120 or 100 epochs and with a batch size of 128. This process is done to increase the accuracy of the model. After this, a graph was plotted to know the values of accuracy and model accuracy as shown in figure 4.

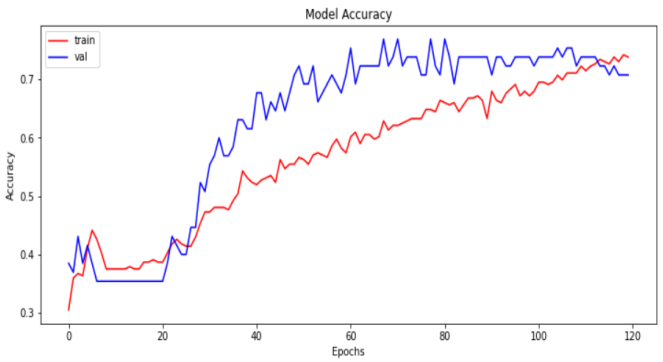

Figure4 Graph of accuracy and model accuracy in the training set

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It shows the difference between the accuracy in the training set.

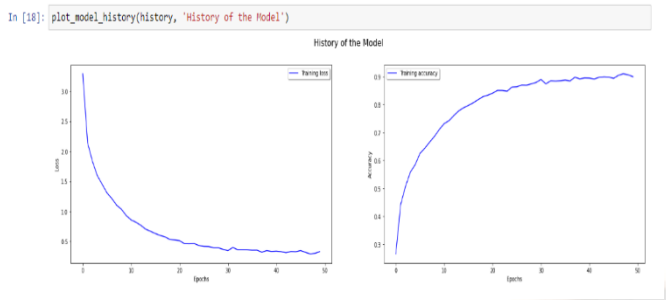

Figure 5 Graph between Training Loss and Training Accuracy

Comparison of accuracy and epochs in ResNet Model by the following Figure 5.

A. Save The Model

While comparing the accuracies we take the best model which is getting the highest accuracy and we save the model for further evaluation. From the above models, ResNet model gives good accuracy when compared with Inception V3. An accuracy of 91 percent from ResNet model and 80 percent from Inception V3 model.

B. Using Flask to Create Webpage

Flask is an application that is used to create a web application by using HTML and CSS and after creating a flask application, it is used to identify the dog breed.

Building Convolutional Neural Network with different pre-trained models such as RESNET-5 and InceptionV3, makes the model more accurate. we take the best model out of them and save the model. Building a flask application and then deploying it. In this entire paper, ResNet is the best model to predict the name of the dog breed with the help of the CNN model. We will come to know that when the CNN model works with Keras and TensorFlow it will work very well and with this when we use different pre-trained models, we will get the best accuracy and without errors.

i. *Login Page*

Once after clicking login page url. User will be redirecting to home page. In home page there are two navbar sections. They are Breed and predict UI sections. Breed section provides all the breeds which the model can predict and predict section allows to upload the dog image to predict the dog breed.

Figure 6. Login Page

ii. *Prediction Page*

In prediction page user can able to give Input as file format and choose the dog image. After choosing dog image by clicking predict button it gives output.

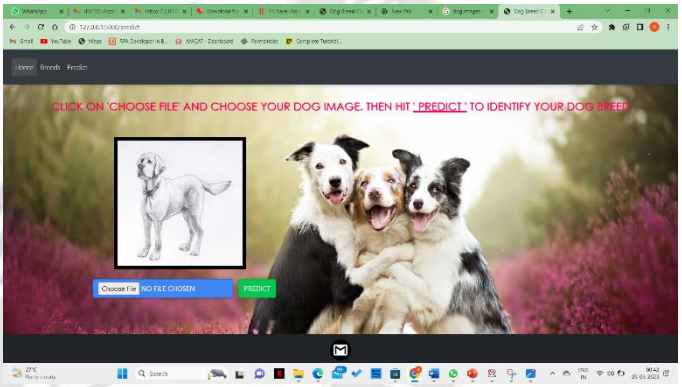

Figure 7. Prediction Page

iii. *Output*

After clicking the predict button. The dog image will be loaded above the browse button. User can see the accuracy level, name of the dog breed and dog image. In the above image accuracy is “99.4%” and dog breed is “Italian Greyhound”.

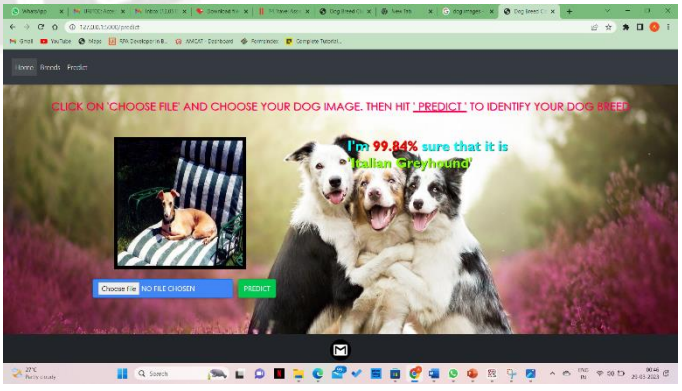

Figure 8. Output Page

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VII. CONCLUSION

The project of identifying dog breeds using the Resnet model has shown that deep learning techniques are highly effective in image recognition tasks. By training the Resnet model on a large dataset of dog images, we were able to accurately classify each image into one of 120 different dog breeds. The Resnet model is a highly sophisticated neural network architecture that has shown to achieve state-of-the-art performance in many image recognition tasks. In this project, the Resnet model was able to achieve an impressive accuracy rate in identifying dog breeds.

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