PROJECT REPORT

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GitHub Link: https://github.com/30Dev/Dog-Breed-Detection

ABSTRACT

Dog Breed identification is a specific application of Convolutional Neural Networks. Though the classification of Images by Convolutional Neural Network serves to be efficient method, still it has few drawbacks. Convolutional Neural Networks requires a large number of images as training data and basic time for training the data and to achieve higher accuracy on the classification. To overcome this substantial time, we use Transfer Learning. In computer vision, transfer learning refers to the use of a pre-trained models to train the CNN. By Transfer learning, a pre-trained model is trained to provide solution to classification problem which is similar to the classification problem we have. In this project we are using pre-trained model Xception to train over 10,000+ images covering 120 breeds of dogs were used as classes for training and obtain bottleneck features from these pre-trained models.

INTRODUCTION

Machine learning may be a subfield of AI (AI). The goal of machine learning generally is to know the structure of knowledge and fit that data into models which will be understood and utilized by people. Although machine learning may be a field within computing, it differs from traditional computational approaches. In traditional computing, algorithms are sets of explicitly programmed instructions employed by computers to calculate or problem solve. Machine learning algorithms instead leave computers to coach on data inputs and use statistical analysis so as to output values that fall within a selected range. Because of this, machine learning facilitates computers in building models from sample data so as to automate decision-making processes supported data inputs. Most of the dog breeds are developed in order to drive some specific things. Knowing the breed of dog can help us to predict and understand the behavior. And this is essential when it comes to managing and training dogs for specific tasks. In machine learning, Convolutional Neural Network (CNN) is complicated feed forward neural networks. CNNs are used for image classification and recognition due to its excessive accuracy. The CNN follows a hierarchical model which struggles on constructing a network, sort of a funnel, and eventually offers out a definitely related layer the place all the neurons are linked to each and every different and consequently the output is processed A computer learns to classify images, text and sound. The pc is trained with large image datasets then it changes the pixel value of the image to an indoor representation, where the classifier can detect patterns on the input image. We proposed a model that uses CNN network to classify images of Dogs. In the Proposed model we are using a model Xception to find the predicted output for a given image.

Background

This project hopes to identify dog breeds from images. This is a fine-grained classification problem: all breeds of Canis lupus familiaris share similar body features and over-all structure, so differentiating between breeds is a difficult problem. Furthermore, there is low inter-breed and high intra-breed variation; in other words, there are relatively few differences between breeds and relatively large differences within breeds, differing in size, shape, and color. In fact, dogs are both the most morphologically and genetically diverse species on Earth. The difficulties of identifying breeds because of diversity are compounded by the stylistic differences of photographs used in the dataset, which features dogs of the same breed in a variety of lightings and positions.

Problem

This problem is not only challenging but also its solution is applicable to other fine-grained classification problems. For example, the methods used to solve this problem would also help identify breeds of cats and horses as well as species of birds and plants - or even models of cars. Any set of classes with relatively small variation within it can be solved as a fine-grained classification problem. In the real-world, an identifier like this could be used in biodiversity studies, helping scientists save time and resources when conducting studies about the health and abundance of certain species populations. These studies are crucial for assessing the status of ecosystems, and accuracy during these studies is particularly important because of their influence on policy changes. Breed prediction may also help veterinarians treat breed specific ailments for stray, unidentified dogs that need medical care. Ultimately, we found dogs to be the most interesting class to experiment with due to their immense diversity, loving nature, and abundance in photographs, but we also hope to expand our understanding of the fine-grained classification problem and provide a useful tool for scientists across disciplines.

LITERATURE REVIEW

[1] Dog Breed Identification with a Neural Network over Learned Representations from the Xception CNN Architecture (K.Mulligan, Pablo Rivas : Published in 2019)

Machine learning is a growing field that has greatly increased with the continuing advancements in technology. This area provides many tools that can perform different tasks on large data sets. The focus of this paper is on classification tools. Classification tools are utilized in order to classify or predict the breeds of dogs based on an input image. Many methods are used in attempts to classify the images in the data set. The data set comes from a Kaggle competition in which the goal is to predict the breed of dog in the image. Participants tried many different methods, some of which helped inspire this research. The classification tools that are explored here are a Convolutional Neural Network and Xception with a Multilayer Perceptron. The paper explores the trial and error in all of the methods as well as the final model that was used to predict and classify the dog breeds. While the final model has a much better prediction rate than the original attempt, there is an acknowledgement of the errors made throughout the process. With this acknowledgement comes areas to improve and ideas to further explore this model as a classification tool.

[2] Dog Breed Identification (Whitney LaRow : Published in 2016)

This project uses computer vision and machine learning techniques to predict dog breeds from images. First, we identify dog facial keypoints for each image using a convolutional neural network. These key points are then used to extract features via SIFT descriptors and color histograms. We then compare a variety of classification algorithms, which use these features to predict the breed of the dog shown in the image. Our best classifier is an SVM with a linear kernel and it predicts the correct dog breed on its first guess 52% of the time; 90% of the time the correct dog breed is in the top 10 predictions.

[3] Dog Breed Identification Using CNN and Web Scraping (M. Sultan, S. Naveen : Published in 2020)

Dogs are domesticated mammals, not natural wild animals. They have been bred by humans for a long time. Today, some dogs are used as pets, others are used to help humans do their work. It's a significant task for the owners to care and maintain their pet dog. For that, they need to know the breed of the dog to train and cure disease. The current paper presents a fine-grained image recognition problem, identifying the breed of a dog in a given image which includes convolution neural networks. The network is trained and evaluated on the Stanford Dogs Dataset. By using web scraping, the data from various websites are collected and rendered in the application.

[4] Dog Breed Identification with Fine Tuning of Pre-Trained Models (B.V. Kumar, K. Bhavya : Published in 2019)

Dog Breed identification is a specific application of Convolutional Neural Networks. Though the classification of Images by Convolutional Neural Network serves to be efficient method, still it has few drawbacks. Convolutional Neural Networks requires a large number of images as training data and basic time for training the data and to achieve higher accuracy on the classification. To overcome this substantial time, we use Transfer Learning. In computer vision, transfer learning refers to the use of a pre-trained models to train the CNN. By Transfer learning, a pre-trained model is trained to provide solution to classification problem which is similar to the classification problem we have. In this project we are using various pre-trained models like VGG16, Xception, InceptionV3 to train over 1400 images covering 120 breeds out of which 16 breeds of dogs were used as classes for training and obtain bottleneck features from these pre-trained models. Finally, Logistic Regression a multiclass classifier is used to identify the breed of the dog from the images and obtained 91%, 94%,95% validation accuracy for these different pre-trained models VGG16, Xception, InceptionV3.

[5] Dog Breed Identification using CNN on Android (D.D. Durga Bhavani, Mir Habeebullah Shah Quadri, Y. Ram Reddy : Published in 2019)

Identifying the breed of a dog, is a challenging image classification problem. In this paper, we implement an android application that identifies the breed of a dog via image analysis, using a Convolutional Neural Network (CNN) and transfer learning model. The android application lets the user click or upload a picture of a dog. It then pre-processes the image and extracts the features required for testing. Prediction of dog breed is done using CNN and transfer learning. We have used Stanford's standard dog dataset for training the model and achieved an accuracy of 94% on the testing data.

[6] Dog Breed Identification Using Deep Learning (Zalan Raduly, Csaba Sulyok, Attila Zolde : Published in 2018)

The current paper presents a fine-grained image recognition problem, one of multi-class classification, namely determining the breed of a dog in a given image. The presented system employs innovative methods in deep learning, including convolutional neural networks. Two different networks are trained and evaluated on the Stanford Dogs dataset. The usage/evaluation of convolutional neural networks is presented through a software system. It contains a central server and a mobile client, which includes components and libraries for evaluating on a neural network in both online and offline environments.

DATASET USED

ImageNet is a large visual database designed for use in visual object recognition software research. Over 14 million images have been hand-annotated by ImageNet to indicate what objects are pictured. The dataset we used is from Kaggle: Dog Breed Identification.

This dataset contains more than 20000 images and totally 120 breeds of dogs, and all the images are from ImageNet. Every image in the dataset has its own ID and corresponding dog breed. The dataset is already divided into two parts ,i.e., train and test. Train Dataset contains 10222 images, and the Test Dataset contains 10357 images.

Further we have divided the Train Dataset into two parts ,i.e., Train Dataset and Validation Dataset for the purpose of preparation of the dataset. The Train dataset contains 8178 images from the 10222 images and the rest of the images are used for the purpose of Validation dataset ,i.e., 2044 images.

All the data are RGB images, and in the center of each image, there is the body of the dog. The features we use are color, shape and texture. As we can distinguish different dog breeds from colors, shape of organs, and texture of the body and so on. CNN uses convolution layers to extract those features from the images. As the number of images in the dataset is not big enough, we also did some pre-processing to enlarge the dataset. We resize all the images to a fixed resolution of 299x299.

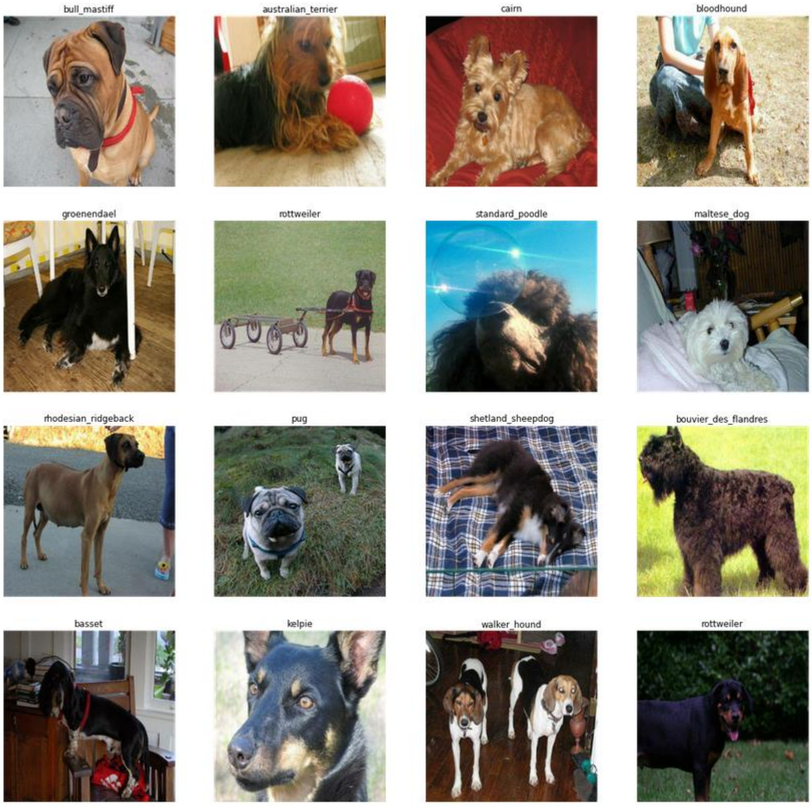

Fig.1 shows an overview of our train dataset.

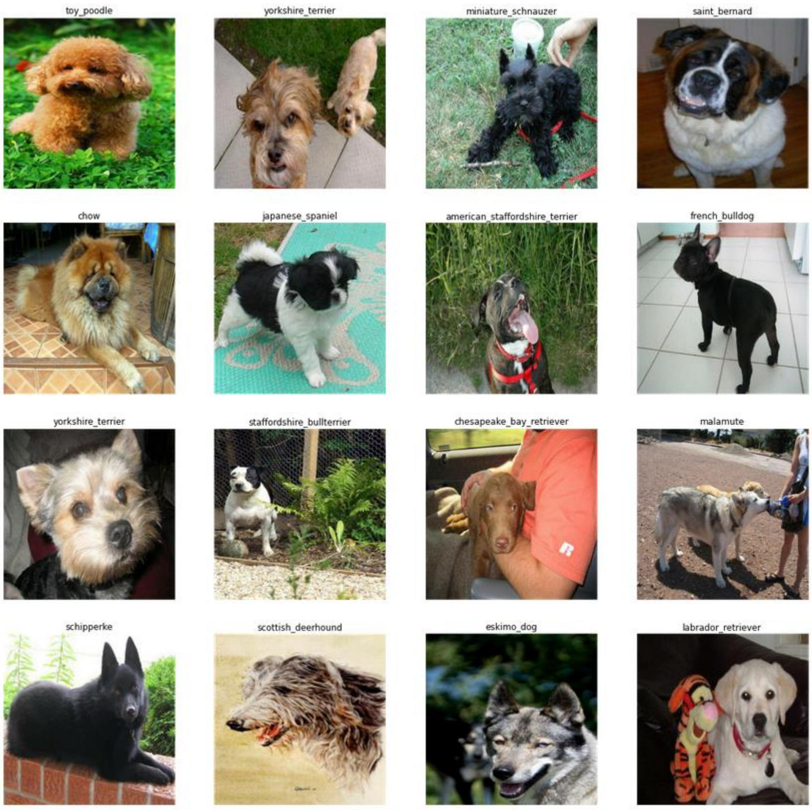

Fig.2 shows an overview of our validation dataset.

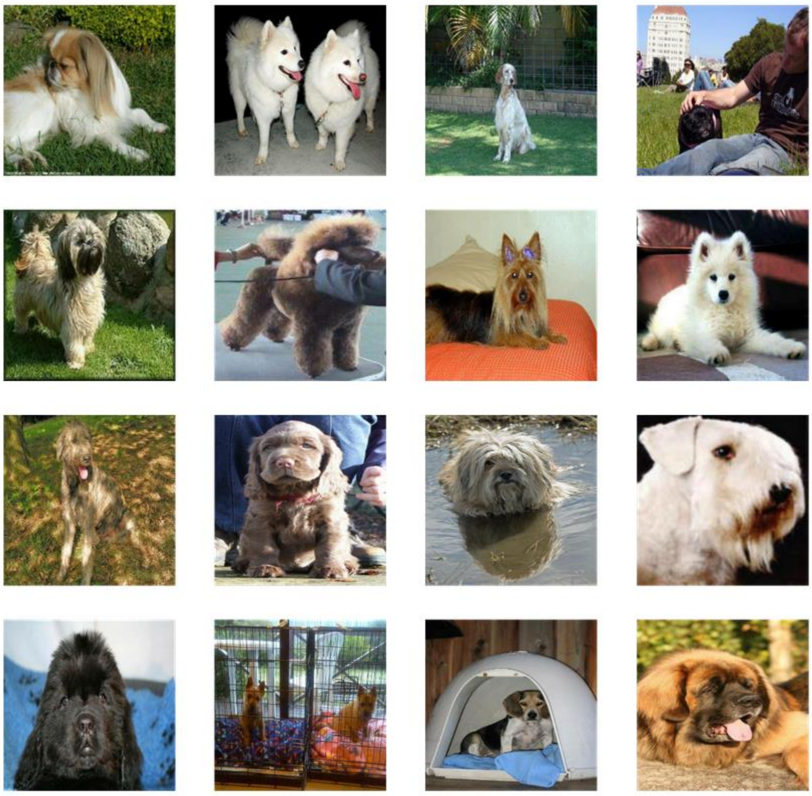

Fig.3 shows an overview of our test dataset.

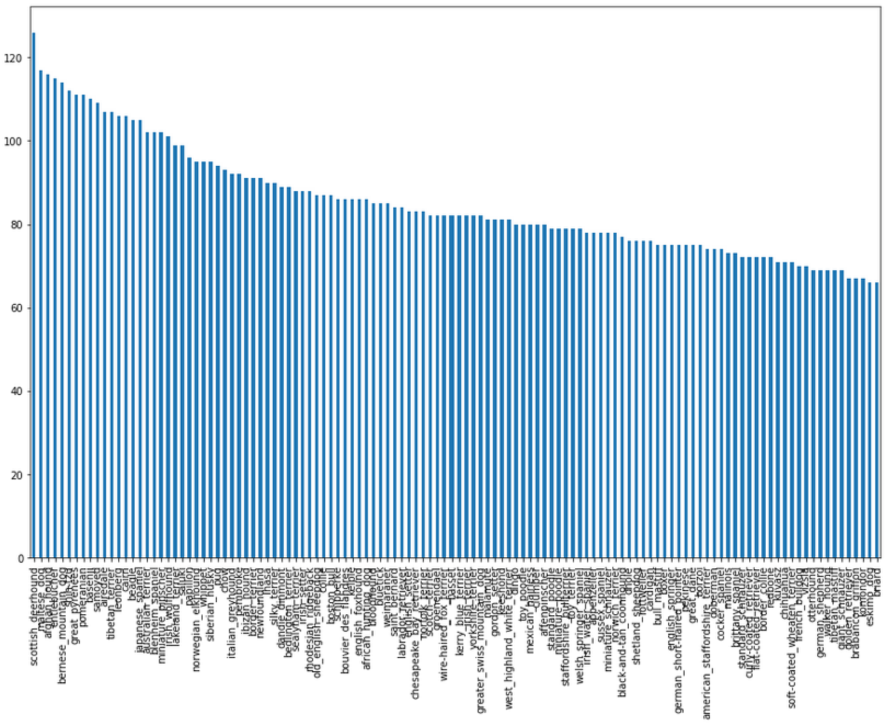

Fig.4 shows the distribution of breeds of dogs in the dataset.

PROPOSED ARCHITECTURE

The created model from scratch is not performing well, due to not having enough images data to train the model. One potential improvement is data augmentation to add more data. This strategy modifies the images by padding, cropping, and rotating images randomly. It also enables the model to generalize better without overfitting, of course, with the appropriate parameters.

As it was mentioned before, training a CNN classifier made from scratch on a small data like this will lead to underfitting and with so many layers, and parameter tuning often causes overfitting. So, it is time to utilize transfer learning pre-trained networks to create a CNN breed classifier even though these models are not explicitly made for this task. But one advantage of these networks is that they are trained on large datasets, ImageNet with millions of labeled images, and reached the 90% accuracy. Also, they can generalize to other images outside the ImageNet.

I implemented the pre-trained models Xception in Keras and compared their accuracy. I added a global average pooling layer and a fully connected layer with a Softmax activation function and 120 nodes for the 120 dog categories. I used them as fixed feature extractors and fine-tuned the fully-connected layer by minimizing the cross-entropy loss function using Adam, and the learning rate of 0.001. Also, the last fully connected layer is changed to the number of dog breeds, 120. Then, the model was trained on 10 epochs with 32 samples each batch. I think this architecture is suitable for the current problem because it has a more efficient use of model parameters than other models and it is known to be already well trained for image classification on ImageNet.

The Xception model outperforms with an accuracy of 90% and a loss of 0.29 on train data.

RESULT AND EXPERIMENT ANALYSIS

After the training of the model, it has been observed that the model was trained very successfully and provides its training accuracy. The epochs were also increased to a certain limit, and it was found that the accuracy was also increasing, and the production was at its best.

Training and Validation Accuracy & Training and Validation Loss for different Epochs

```
Epoch 1/10
256/256 [==============================] - 59s 195ms/step - loss: 1.6737 -
accuracy: 0.6804 - val_loss: 0.4697 - val_accuracy: 0.8845
Epoch 2/10
256/256 [==============================] - 43s 170ms/step - loss: 0.5613 -
accuracy: 0.8481 - val_loss: 0.3433 - val_accuracy: 0.9012
Epoch 3/10
256/256 [==============================] - 44s 170ms/step - loss: 0.4649 -
accuracy: 0.8662 - val_loss: 0.3162 - val_accuracy: 0.8977
Epoch 4/10
256/256 [==============================] - 43s 170ms/step - loss: 0.4155 -
accuracy: 0.8759 - val_loss: 0.2943 - val_accuracy: 0.9095
Epoch 5/10
256/256 [==============================] - 44s 170ms/step - loss: 0.3792 -
accuracy: 0.8838 - val_loss: 0.2890 - val_accuracy: 0.9051
Epoch 6/10
256/256 [==============================] - 44s 171ms/step - loss: 0.3579 -
accuracy: 0.8847 - val_loss: 0.2900 - val_accuracy: 0.9066
Epoch 7/10
256/256 [==============================] - 44s 171ms/step - loss: 0.3403 -
accuracy: 0.8963 - val_loss: 0.2863 - val_accuracy: 0.9046
Epoch 8/10
256/256 [==============================] - 44s 170ms/step - loss: 0.3165 -
accuracy: 0.9002 - val_loss: 0.2847 - val_accuracy: 0.9036
Epoch 9/10
256/256 [==============================] - 43s 170ms/step - loss: 0.3016 -
accuracy: 0.9019 - val_loss: 0.2862 - val_accuracy: 0.9061
Epoch 10/10
256/256 [==============================] - 43s 170ms/step - loss: 0.2846 -
accuracy: 0.9078 - val_loss: 0.2882 - val_accuracy: 0.9041
```

Training and Validation Accuracy

It can be observed from the Fig.5 that during the training period the model attained a maximum Training Accuracy of about 90.8% and maximum Validation Accuracy of about 90.4% with epochs equal to 10.

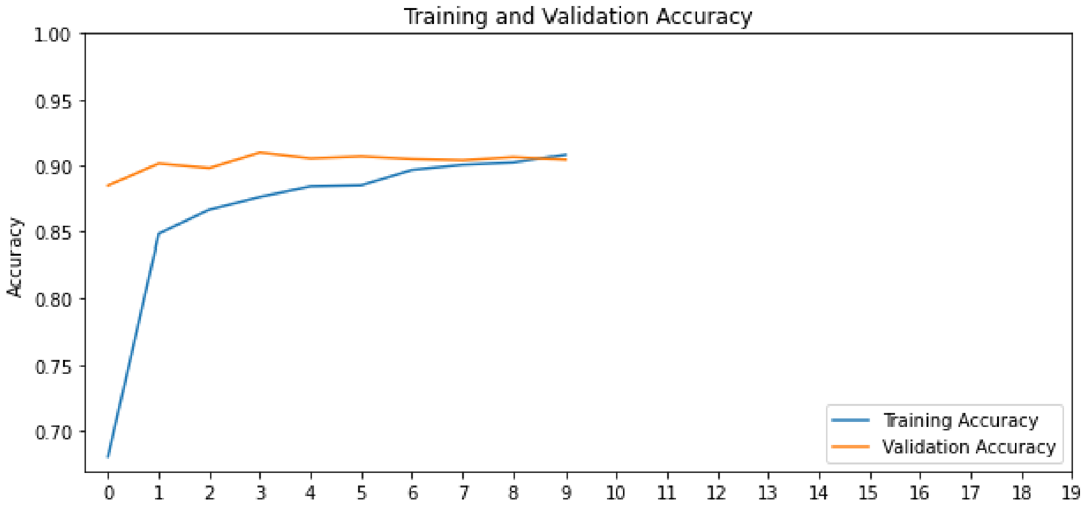

Fig.5 shows the Training and Validation Accuracy of the dataset.

Training and Validation Loss

It can be observed from the Fig.6 that during the training period the model attained a Training Loss of 0.2846 and Validation Loss of 0.2882.

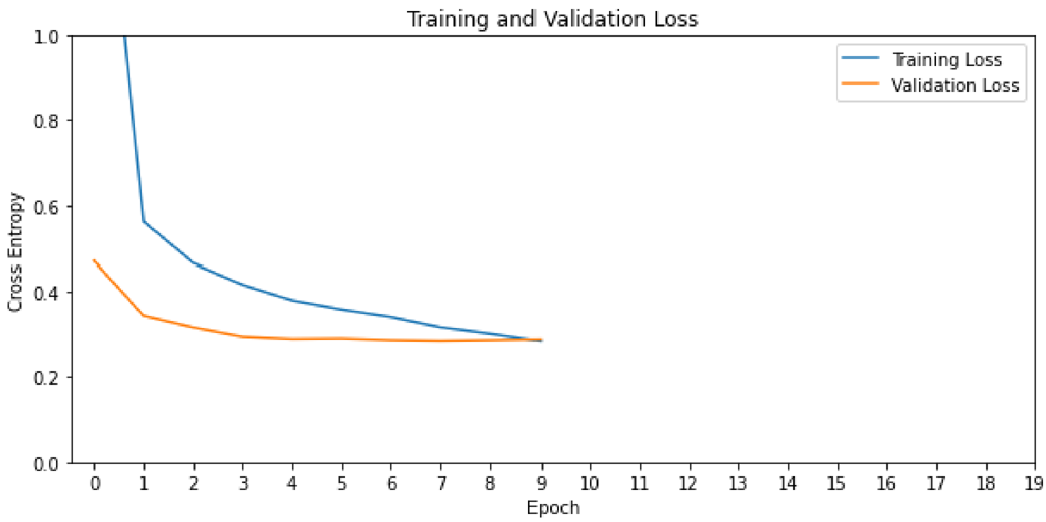

Fig.6 shows the Training and Validation Loss of the dataset.

Prediction

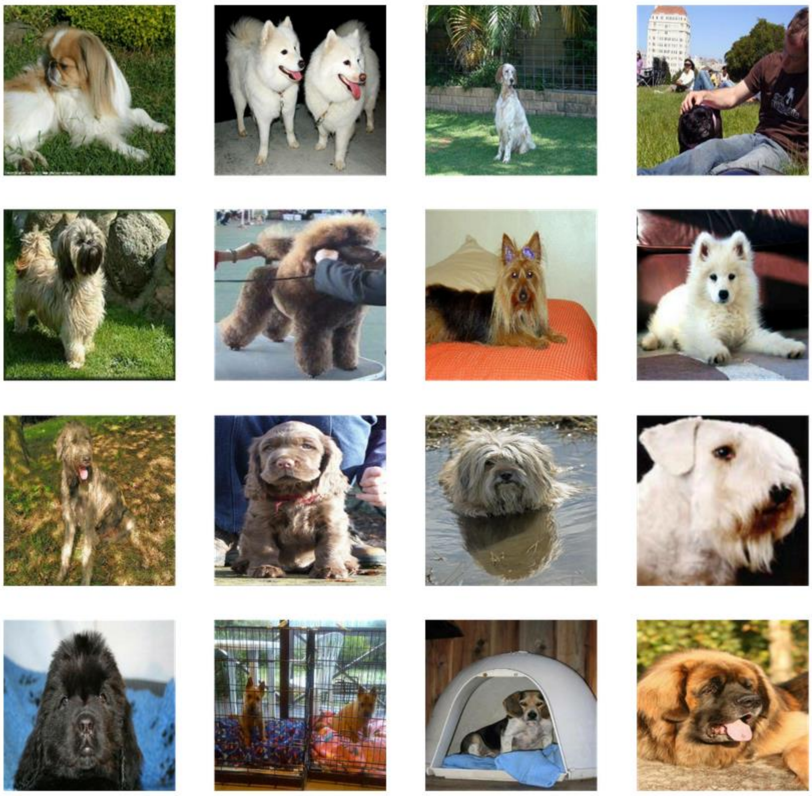

Fig.7 shows the data on which we have tested the model.

```
1 japanese_spaniel
2 samoyed
3 english_setter
4 pug
5 lhasa
6 irish_water_spaniel
7 australian_terrier
8 samoyed
9 irish_wolfhound
10 sussex_spaniel
11 tibetan_terrier
12 sealyham_terrier
13 newfoundland
14 dhole
15 beagle
16 leonberg
```

Fig.8 shows the predicted dog breed for the test data.

CONCLUSION & FUTURE SCOPE

In this system Convolutional neural network is a learning method for data analysis and predictions, now days it also become very popular for image classification problems. Dog breed prediction of deep learning developed using convolutional neural network is to predict the learning on the way to build model that make output and around to hundreds of dissimilar dog types. The results were pretty good for the images the model was shown. The algorithm was able to identify dog breeds quite exactly. Transfer built model by the model we created.

Future work should further explore the potential of convolutional neural networks in dog breed prediction. Given the success of our key point detection network, this is a promising technique for future projects. That said, neural networks take an enormous time to train, and we were unable to perform many iterations on our technique due to time constraints. We recommend further exploration into neural networks for key point detection, specifically by training networks with a different architecture and batch iterator to see what approaches might have greater success. Also, given our success with neural networks and key point detection, we recommend implementing a neural network for breed classification as well since this has not been performed in the literature. We were unable to experiment with this approach due to the time constraints of neural networks but believe that they would match if not improve upon our classification results. Ultimately, neural networks are time consuming to train and iterate upon, which should be kept in consideration for future efforts; still, neural networks are formidable classifiers that will increase prediction accuracy over more traditional techniques.

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[3] https://www.semanticscholar.org/paper/Dog-Breed-Identification-Using-Convolution-Neural-Sultan-Naveen/f13dca1b50510fd50d504c7599eb1f1ac323f6fc

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