

# Dog Breed Classification

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## I. INTRODUCTION

Inside the present day global, there are numerous various kinds and organisms. This demonstrates how critical it's miles to categorize various tangible items. In view of the ongoing genetics and evolution studies being done with the aid of professionals everywhere in the global, figuring out the commonalities among various training also turns into crucial. The test that furnished the premise for this essay was classifying distinct canine breeds the usage of a CNN (Convolutional Neural network). This algorithm will discover an envisioned breed if a dog photo is determined. The breed of dog that maximum closely resembles a human is identified if a human image is provided. to deal with pictures taken within the real world, we constructed a pipeline.

The puppies were frequently saved as family pets and play an critical role inside human households. On the opposite aspect, there are increasingly more incidences of violence and unruly behavior involving puppies. due to this, canine identity the usage of contemporary optical technologies became important for both canine popularity and more specific breed classification. puppies' breeds screen much extra approximately them than simply their outward look. various breeds of puppies might also have one-of-a-kind temperaments, desires for area and temperature, schooling necessities in phrases of effort and time, fee and fee, and so forth. therefore, it can be beneficial if households ought to consider all the statistics whilst selecting their pets in preference to focusing entirely on how the applicants look. This inspires the idea of classifying canine breeds from pix, which belongs to a quality-grained class recognition task. applications like object categorization, and scene identity, in addition to different packages, have all benefited substantially from using convolutional neural networks (CNN). we are capable of envision the various features that CNNs (both low-degree and higher-stage) learn at some stage in education. however, whilst the objects that CNNs are seeking to categorize proportion a whole lot of the equal developments as extraordinary canine breeds do, it might be challenging to picture the precise features that CNNs will need to examine if you want to accurately label these dogs. that is specially true if we observe collections of snap shots in which the three dogs almost absolutely percentage the same visual traits however come from specific training. therefore, it is fascinating to observe how well CNNs can

execute on simplest canine in comparison to labels from all item training within the trendy ImageNet, breeds. Dogs



Fig. 1. A representation of many dog breeds. We can see from the examples given that there are frequently quite small differences between various dog breeds.

breeds screen a whole lot more about them than simply their outward look. numerous breeds of dogs may also have distinctive temperaments, desires for area and temperature, schooling requirements in terms of time and effort, value, and fee, and so on. therefore, it is able to be useful if families could don't forget all the information while selecting their pets in preference to focusing totally on how the candidate's appearance. This inspires the idea of classifying canine breeds from pix, which belongs to a nice-grained class popularity challenge. On categorization at the subordinate level, many works have been centered. Within the same basic-level class, this issue presents categories of related items, such as several dog breeds. Our research focuses on classifying dog breeds in this study. The biggest challenge is that there isn't much of a distinction between classes. It is a more difficult problem since fewer discriminative features can be used than in basic-level categorization. This problem isn't only hard but additionally, its answer is relevant to different high-quality-grained type troubles. as instance, the methods used to clear up this problem might additionally assist become aware of breeds of cats and horses in addition to species of birds and plant life - or maybe

models of motors. Any set of instructions with particularly small variation within it can be solved as a fine-grained type hassle. inside the actual-global, an identifier like this could be used in biodiversity research, supporting scientists shop time and resources when accomplishing research about the fitness and abundance of positive species populations. those studies are crucial for assessing the reputation of ecosystems, and accuracy in the course of those research is specially essential due to their have an effect on on policy modifications. Breed prediction can also assist veterinarians deal with breed unique ailments for stray, unidentified dogs that want medical care. in the end, we discovered puppies to be the maximum thrilling magnificence to experiment with because of their great range, loving nature, and abundance in photographs, however we also wish to increase our know-how of the excellent-grained category hassle and provide a useful tool for scientists across disciplines.

## II. RELATED WORK

[1] One in all the sooner works in satisfactory-grained class turned into an try at identifying plant species by Belhumeur et. al. This technique worried segmenting a leaf and then the use of form to determine the species. along similar traces, a paper via Farrell et. al tried to identify a birds species via locating keypoints along the beak, eyes, wings, ft, and tail, and building functions round them. masses of previous paintings has been finished in the discipline of finegrained category, and we used this literature to broaden an know-how of the field. Likewise, there was a fair quantity of research that has been done into element localization, which we closely leverage in our venture. however, we ordinarily targeted on category within species in our literature evaluate, which bears closest resemblance to our trouble. before people discovered a way to use the energy of deep learning, the high-quality recognised technique turned into to carefully manually layout the capabilities. usually, those features may want to only be applied to some specific slim set of problems. To address the problem of picture categorization used a more than one kernel framework to mix kernels in a manner that is maximum discriminative for each magnificence. extensively utilized the framework as part of an interactive device for chicken species identification more relevantly, but, a 2012 paper with the aid of Liu et. al attempted dog breed identification using a comparable method. They first use an SVM regressor the usage of greyscale

[2]A less complicated trouble this is just like dog categorization, is the problem of cats vs puppies classification, and a whole lot of work has been carried out on it.a classifier based totally on coloration functions got fifty-six. Nine% accuracy at the Asirra" puppies vs Cats" dataset. Golle et al performed an accuracy of 82.7% with the use of an assist Vector Machines classifier primarily based on a mixture of color and texture features. researchers used the SIFT (Scale-Invariant characteristic rework) capabilities to train a classifier and sooner or later were given an accuracy of 92.nine% on the dogs vs Cats trouble. With improvements of CNNs, the accuracyrates elevated extensively. SIFT descriptors as

capabilities to isolate the face of the dog. To handler rotation and scale, the window is likewise rotated and scaled; through using non-most suppression and choosing the detection with the highest rating, they isolate a single first-rate window. The primary attention of the mission is to find the facial keypoints of the dog. Liu et. al leverages a component localization algorithm, in which a sliding window SVM detector using 1 SIFT greyscale descriptors is used over every eye and nose. After the eyes and nostril have been detected, greyscale SIFT descriptors around the keypoints are used as functions with the aid of an SVM classifier. With this method, Liu et. al is capable of classify their test dataset with an accuracy of about 90

## III. PROPOSED METHOD

This paper gives a dog breed classifier that can able to detect breed of the given dog picture and it regardless of arrangement and train it in a right neural machine to get specific outcomes. It takes an RGB enter photo from any orientation to obtaining output. the primary work of this characteristic is feature extraction and sophistication prediction to the pix. within the function extraction device, the picture is sketched and created into a new photograph in which the generated photo is more green than the preceding image. in this component, a massive number of snap shots dimensionally reduce to an green illustration in which an exciting a part of the image is captured. After doing capabilities extraction in each convolutional layer it offers an output that works better for the image and represents the ones photos a set of categorized snap shots. background noise also reduces and performs filtering to cast off excessive frequency from the input image. After completing the education system it offers us some model data with their accuracy stage. on this machine three-parts training session to complete the process, the primary component is connected with the dataset, the second is created a few model with accuracy, and the 1/3 component is to detect the breed.

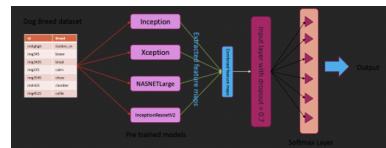


Fig. 2. Structure of proposed model

The primary concept right here is to extract functions from the statistics set from pretrained fashions and create a simple deep internet with the aid of the use of all those functions mixed. firstly a few pixels of an input picture enter into a primary convolutional layer, then the ones convoluted pixels admin into the second one max-polling layer. The output of the max-polling layer equipped for entire the second convolutional layer. After computing the second one max-polling layer the pixels are prepared for the absolutely related layer.

## IV. EXPERIMENTS

In this project first we extract features from the dataset by a given pretrained model. we used four Pre-trained Archi-

ture which are InceptionV3, Xception, InceptionResNetV2, NASNetLarge. we use uint8 as data type of images as we have huge data and limited ram memory as uint8 takes less memory. we convert the image to integer as we need the input in numerical format. we will create as we are using models of keras applications our input shape has three values and we have to stick with predefined limits of pretrained architectures. we will extract the dog breed information and will read and save images in numpy array. we will set learning rate as .001 by creating the callbacks it will monitor the validation accuracy and reduce the learning rate. we are creating the batch size of 128 and 50 epochs After we extract the features from the dataset using those four pretrained models we create a simple deep net by using the features we extracted. we will be GlobalAveragePooling2D to extract a pooled output from our models. so the input layer will be with dropout 0.7 and next we apply softmax classifier and the output will be produced. For each pretrained model we have a preprocessor unit. We extract feature from dataset using four pretrained models separately and then combine them all to form a final feature map. after creating final feature map we are ready to build a model with dropout 0.7. we will prepare the deep net and Train the model. In our case after running 12 epochs we have tuning accuracy reaches to 98.8 and validation accuracy of 94.4

```

Epoch data
Epoch 1/50 loss: 2.2120 - accuracy: 0.5852 - valloss : 0.1928
- val_accuracy : 0.9413Epoch2/50loss : 0.1902 - accuracy :
0.9408 - valloss : 0.1782 - val_accuracy :
0.9457Epoch3/50loss : 0.1470 - accuracy : 0.9529 - valloss :
0.1854 - val_accuracy : 0.9379Epoch4/50loss :
0.1068 - accuracy : 0.9676 - valloss : 0.1907 - val_accuracy :
0.9364Epoch5/50loss : 0.0862 - accuracy : 0.9720 - valloss :
0.1832 - val_accuracy : 0.9443Epoch6/50loss :
0.0735 - accuracy : 0.9784 - valloss : 0.1861 - val_accuracy :
0.9389Epoch7/50loss : 0.0626 - accuracy : 0.9795 - valloss :
0.1886 - val_accuracy : 0.9413Epoch8/50loss :
0.0551 - accuracy : 0.9839 - valloss : 0.1949 - val_accuracy :
0.9389Epoch9/50loss : 0.0467 - accuracy : 0.9870 - valloss :
0.1987 - val_accuracy : 0.9403Epoch10/50loss :
0.0401 - accuracy : 0.9893 - valloss : 0.2024 - val_accuracy :
0.9369Epoch11/50loss : 0.0431 - accuracy : 0.9856 - valloss :
0.2084 - val_accuracy : 0.9403Epoch12/50loss :
0.0386 - accuracy : 0.9882 - valloss : 0.1938 - val_accuracy :
0.9447

```

Fig. 3. Epoch data

Now we will create a function to read images from test directory present in the dataset and after reading the image from dataset it will show the data size of output. Once it is done we will extract the features from test data using those four pre-trained architectures and combine those to final features and we will map the features. No that we have feature date we will predict test lables with test data features. we will run the first prediction we can know the probability of prediction from output.

#### A. Datasets

This dataset contains 120 dog breeds. The schooling set carries 10,222 canine photographs. so one can build our fashions and calculate their accuracy, we used handiest the schooling set from Stanford. We cut up the Stanford training Set into a train set (eight,185 snapshots), a validation set

```

[7.77037448e-06 2.76386436e-06 7.74598887e-06 2.12222676e-06
2.57623533e-06 3.29470095e-05 3.17281592e-05 1.40956617e-04
4.18569061e-06 1.23210275e-05 5.04044920e-06 1.14162451e-06
3.881843e-06 1.23629889e-05 4.97491548e-06 1.00158573e-05
1.58113889e-05 8.83773537e-05 3.15015313e-06 5.30920152e-05
7.12992595e-06 4.10575449e-04 2.78211330e-05 2.11660563e-06
1.17515653e-06 6.41794977e-05 4.76117530e-05 1.22428792e-05
1.30423702e-05 9.57436441e-06 2.01303064e-05 2.43281306e-06
4.80864855e-06 1.34078719e-05 6.74728199e-07 6.32107867e-06
5.97543249e-06 2.73799933e-05 1.25321765e-06 6.17393243e-06
3.13044416e-06 1.35411085e-06 4.77956988e-06 1.24265116e-05
4.12064090e-06 6.91166570e-05 3.62274864e-06 7.20718344e-06
1.16541889e-06 4.47872489e-06 5.24594361e-06 1.08133436e-05
4.62601565e-06 1.03220533e-05 3.44264843e-06 1.41218579e-05
1.85961051e-06 5.64907558e-06 1.90897566e-06 5.5942618e-05
1.48623445e-05 1.41932937e-05 4.24287333e-06 2.35499056e-05
5.76800547e-05 5.74809146e-06 4.28302337e-06 3.71874205e-06
1.59802939e-05 1.76370286e-05 3.39095914e-05 4.25429726e-06
3.76782396e-06 2.09168844e-05 1.94278009e-05 5.97320250e-05
9.05559773e-06 2.29106736e-05 5.84966710e-06 5.49425567e-05
1.97588815e-05 9.48891011e-06 1.33301444e-06 7.14778980e-06
1.20235825e-05 5.86103652e-06 4.65432868e-06 7.18079764e-06
1.08975248e-05 6.51024084e-06 1.10151086e-05 1.40759666e-05
7.39618872e-06 8.65507616e-07 5.26974145e-06 3.02269546e-05
7.70348834e-05 3.06093752e-05 1.71281081e-05 5.13809391e-06
4.89681315e-06 1.89965685e-05 2.34964318e-05 1.52654375e-05
9.7194273e-06 8.99212580e-07 1.44865504e-05 1.20240366e-05
1.23452928e-06 1.73925764e-05 5.21729544e-06 5.24338066e-05
1.02632305e-05 2.09253775e-06 2.42102760e-06 2.35249905e-06
2.34623614e-05 9.09738519e-05 3.68871272e-05 8.99291899e-06
Max value (probability of prediction): 0.971944272518158
Sum: 1.00000001192092896
Max index: 104
Predicted label: staffordshire_bullterrier

```

Fig. 4.

(1,1/2 photos), and a test set (1,022 snapshots). We did this because we best had the labels for the training set. This dataset contains photos of puppies, a few carrying clothes, a few with human beings, and puppies of various sizes and with special backgrounds.

Image inside the educate and check document has a completely unique identification and the actual breed of every picture is paired with particular IDs in one-of-a-kind csv files. In general, we used 10,222 photographs. images include each simple clean photographs of dogs, as well as photographs with numerous variations. for instance; dogs with clothes, puppies with humans, or side view of the canine's face etc. This excessive inter-elegance variance and low intra-magnificence variance among photos delivered our crew to attention on quality-grained popularity as opposed to easy class. We did a bit of Exploratory data analysis (EDA) to be able to get a clearer photo of the breeds and the images we were going to be working with. We study the distribution of the number of breeds of our given records. This graph below show that breeds represented the maximum. those breeds are about double the least present breeds. on the way to better see this, we checked out just the top five breeds and the bottom 5 breeds.

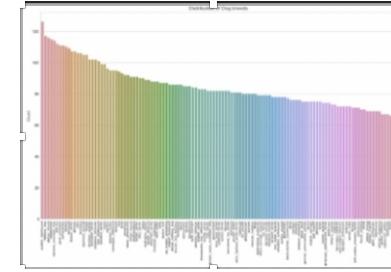


Fig. 5. Distribution of dog breeds

The pinnacle breeds are Scottish deerhound, Maltese dog, Afghan hound, Entlebucher, and Bernese mountain canine. some of the pinnacle five breeds, Scottish deerhound and Maltese have distinguishable appearance as compared to oth-

ers. The last 3 breeds have a comparable blend of colors to each other. on the way to enforce our models, we should first standardize the scale of all of the photos, meaning for every model there's a particular size the picture need to be 224X224 for Mobile Net, ResNet50, VGG16, and InceptionV3. The photograph need to be 229X229 for Xception. function Extraction is a vital part of picture popularity fashions. For our switch studying version InceptionV3, we used the ImageNet pre-skilled weights for characteristic extraction.

	<b>id</b>	<b>breed</b>
0	000bec180eb18c7604dcecc8fe0dba07	boston_bull
1	001513dfcb2ffaf82ccc4d8bbaba97	dingo
2	001cdf01b096e06d78e9e5112d419397	pekingese
3	00214f311d5d2247d5fe4fe24b2303d	bluetick
4	0021f9ceb3235effd7fcde7f7538ed62	golden_retriever

Fig. 6.

	<b>id</b>	<b>breed</b>
count	10222	10222
unique	10222	120
top	4240aa05faa5a88b85103ec5fccbafad	scottish_deerhound
freq	1	126

Fig. 7.

## B. Evaluation Results

We also tested the model with custom input by adding a dog image file into the custom input folder and providing the link to custom data. The custom image will be loaded and converted to np array and we will predict test labels given test data feature map predicted label will be displayed and we got hundred percent prediction accuracy.

```
1/1 [=====] - 2s 2s/step
Feature maps shape: (1, 2048)
1/1 [=====] - 1s 907ms/step
Feature maps shape: (1, 2048)
1/1 [=====] - 6s 6s/step
Feature maps shape: (1, 4032)
1/1 [=====] - 4s 4s/step
Feature maps shape: (1, 1536)
Final feature maps shape (1, 9664)
Predicted label: golden_retriever
Probability of prediction): 100 %
```

Fig. 8. Results

The graph below shows, model accuracy and loss for the given set of train and test images across the model.

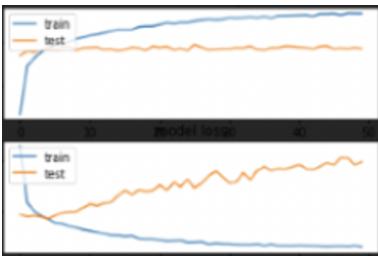


Fig. 9.

## V. CONCLUSION

Normal, we recollect our results to be a fulfillment given the high wide variety of breeds in this first-rate-grained category trouble. we are capable of efficaciously are expecting the correct breed. We have been able to achieve higher accuracy charge whilst compared to fashions which can be already existing we had been able to obtain hundred percent prediction accuracy for custom enter. We had a total of 10,222 dog pix, which we then looked after into one hundred twenty special breeds. due to the small pattern length, there were a restricted range of training snap shots in keeping with elegance, which made figuring out smaller nuances among similar breeds extra hard. Future paintings should in addition explore the capacity of convolutional neural networks in dog breed prediction. Given the achievement of our key point detection network, that is a promising method for destiny tasks. That said, neural networks take a sizeable time to educate and we were not able to perform many iterations on our approach because of time constraints. We propose further exploration into neural networks for key point detection, in particular via training networks with a special architecture and batch iterator to peer what strategies may have extra success. ultimately, neural networks are time-ingesting to train and iterate upon, which should be stored in consideration for future efforts; nevertheless, neural networks are formidable classifiers to be able to boom prediction accuracy over extra conventional techniques. A number of the tactics that would doubtlessly similarly improve the accuracy are: 1) extra competitive records augmentation, 2) more aggressive dropout, 3) Use of L1 and L2 regularization. four) adding greater photographs to the education dataset. With a large dataset we once more can pleasant-song the weights with much less of a risk to overfit.

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