Dog Breed Identification and Age Detection using Neural Networks

Parthesh Haswar[1], Aditya Iyer[2], Prachiti Godhane[3], Amisha Jadhav[4], Dr. Ankita Malhotra[5]
[1,2,3,4] *Student, MCT Rajiv Gandhi Institute of Technology, Mumbai*
[5]*Faculty, MCT Rajiv Gandhi Institute of Technology, Mumbai*

***Abstract*— In this work, dog breed identification and dog age detection is proposed. Python and TensorFlow are used to write the program. TensorFlow is an open-sourcedeep learning framework created by Google that gives developers granular control over each neuron (known as a "node" in TensorFlow) so we can adjust the weights and achieve optimal performance. The breed identification and age detection of dogs is done using CNN, KNN and SVM algorithms and the best accuracy was found to be 97.8% for breed identification and 77.4% for age detection of dogs for the CNN model.**

Index Terms: **Image Classification, Tensor flow, Deep Learning, Neuron, Feature, Libraries, Neural Networks.**

I.INTRODUCTION

The main purpose of the work is the identification of various breeds of dogs and to predict the age of dogs using machine learning algorithms up to an accuracy rate of 97% .Both breed identification and age detection of dogs is done using CNN, KNN and SVM algorithms .All the three models provides different accuracy rates .The comparison of all the three models shows that highest accuracy for dog breed as well as age identification is achieved using the CNN model. Hence the age detection of dogs is achieved for the first time. One of the most popular techniques used in improving the accuracy of image classification is Convolutional Neural Networks (CNNs for short).

Convolutional Neural Network: A special type
Neural Networks that works in the same way of a regular neural network except that it has a convolution layer at the beginning. Instead of feeding the entire image as an array of numbers, the image is broken up into a number of tiles, the machine then tries to predict what each tile is. Finally, the computer tries to predict what's in the picture based on the prediction of all the tiles. This allows the computer to parallelize the operations and detect the object regardless of where it is located in the image.

Structure of an Image Classification Task:

- Image Preprocessing - The aim of this process is to improve the image data(features) by suppressing unwanted distortions and enhancing of some important image features so that our Computer Vision model scan benefit from this improved data to work on.
- Detection of an object - Detection refers to the localization of an object which means the segmentation of the image and identifying the position of the object of interest.
- • Feature extraction and Training- This is a crucial step wherein statistical or deep learning methods are used to identify the most interesting patterns of the image, features that might be unique to a particular class and that will, later on, help the model to differentiate between different classes. This process where the model learns the features from the dataset is called model training.
- Classification of the object - This step categorizes detected objects into predefined classes by using a suitable classification technique that compares the image patterns with the target patterns.

II. PROBLEM STATEMENT

Remembering the breed of a dog or estimating the age of the dog just by looking at the images is a difficult task. Age estimation is harder in dogs as compared to humans because for humans some features automatically detectable from images and useful for evaluation of biological age in humans are wrinkles, sagginess, pigmentation alterations such as

freckles and age spots. Some studies on dog aging point out some important features related to dogs appearance that can be used when assessing dogs aging health such as the texture of the skin, hyperpigmentation alopecia, cataracts, and greying hair.

To solve this problem this project helps to identify and perform fine-grained image classification with 120 different breeds of dogs and a limited number of training images per class. This project will also determine the age of dogs and classify them into three categories namely young(0-2years), adult(3-6years), senior(>6 years).

III. LITERATURE SURVEY

In [1] the main principle is to implement Image classification with Deep learning and Convolution Neural Networks using Tensor flow. Is focused on a machine leaning model which classifies the breed of the dog from an image. Then in [2] the main a i m being adeep learning approach to identify dog breeds. It Used transfer learning by retaining pre trained CNNs. It is basically an image classification model which achieves a promising accuracy of 89.92% on the published dataset with 133 dog breeds "Dog Breed Classifier using Convolutional Neural Networks. Furthermore in [3] the basic principle is to implement Image classification with Deep learning. It is a machine leaning model which identifies the breed of dog from an image.

In [4] the main principle was to find a deep learning approach to identify dog breeds. Its main outcome was an image classification model which has an accuracy of 89.92% on a dataset of 133 dog breeds. To continue with the literature survey, [5] was focused on implementing an Image classification model with Deep learning. A model which identifies the breed of the dog from animage by using CNN. Next, in [6] the purpose was to find a deep learning approach to identify various breeds of dogs.

Then, in [7] the main focus was dog breed classification using size and position of each local part. In [8] the aim was to classify dog breeds using deep learning approach. Lastly, [9] consisted of a Dog Breed Classification model Based on Deep Learning which used transfer learning by retaining pertained CNNs.

As none of the papers in the literature survey studied the age detection factor in dogs, so in this project a dataset of 50 images is created each for young, adult and old category for age determination in dogs using the CNN, KNN and SVM machine learning algorithms and found the accuracy. Ultimately, all the three models were compared based on the accuracy and it was observed that CNN is preferred over the other two algorithms.

IV. PROPOSED SYSTEM

This project consists of 3 main phases namely:

1. Data preparation
2. Model Training
3. Testing

Since the project focuses on dog face images, the data preparation step is required. Then, it is split for the training process and testing process. The output from the training model is a dog breed model and an age estimator. The model is used for breed classification, age estimation and model evaluation. The basic procedure for the implementation of the project is:

1 Understanding the problem: Getting the objectives of the project and understand its implementation.

2 Data Collection: Collecting the data used to train the model. Data is collected from kaggle.com /c/dog–breed identification/data http://tech4 animals.haifa.ac.il/dog challenge

3 Data Preparation: Importing the data to the project environment and making it suitable for further analysis.

4 Exploratory Data Analysis: Learning more about the data along with handling the errors in the data like missing values, null data etc.

5 Modeling: Build a model for breed identification and make another model for Age estimation.

6 Model Evaluation: Evaluate the performance of the model using the validation dataset and make predictions based on the accuracy of the model.

V. METHODOLOGY

Neural Networks: Artificial neural networks (ANNs), usually simply called neural networks (NNs), are computing systems inspired by the biological neural networks that constitute animal brains. Neurons may

have a threshold such that a signal is sent only if the aggregate signal crosses that threshold. Typically, neurons are aggregated into layers. Different layers may perform different transformations on their inputs. Signals travel from the first layer (the input layer), to the last layer (the output layer), possibly after traversing the layers multiple times.

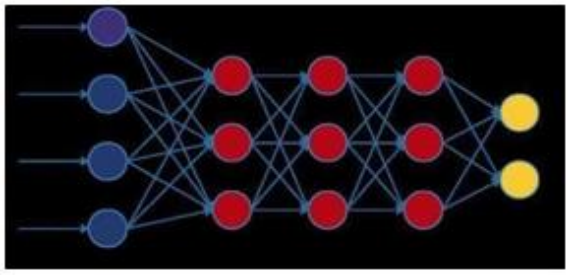

Fig.1 Neural Network representation

Fig.1 represents a basic neural network. In the figure 4.1 the blue circles represent the input layer, the red circles are the multiple hidden layers and the yellow circles are the output layer.

Convolution Neural Network (CNN):

A convolutional neural network consists of an input layer, hidden layers and an output layer. In a convolutional neural network, the hidden layers include layers that perform convolutions. Typically this includes a layer that performs a dot product of the convolution kernel with the layer's input matrix. This product is usually the Frobenius inner product, and its activation function is commonly ReLU. As the convolution kernel slides along the input matrix for the layer, the convolution operation generates a feature map, which in turn contributes to the input of the next layer.

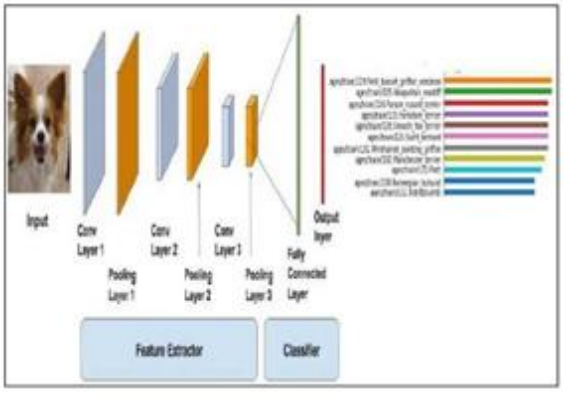

Fig.2 Basic Architecture of a CNN model

Convolutional layers:

In a CNN, the input is a tensor with a shape: (number of inputs) x (input height) x (input width x (input channels). After passing through a convolutional layer, the image becomes abstracted to a feature map, also called an activation map, with shape: (number of inputs) x(feature map height) x(feature map width)x(feature map channels).

Convolutional layers convolve the input and pass its result to the next layer.

Spatial arrangement:

Three hyper parameters control the size of the output volumeof the convolutional layer: the depth, stride and padding size.

1 The depth of the output volume controls the number of neurons in a layer that connect to the same region of the input volume.
2 Stride controls how depth columns around the width and height are allocated. If the stride is, then we move the filters one pixel at a time. This leads to heavily overlapping receptive fields between the columns, and too large output volumes. For any integers stride S means that the filter is translated S units at a time per output. In practice, is rare. A greater side means smaller overlap of receptive fields and smaller spatial dimensions of the output volume.
3 Sometimes, it is convenient to pad the input with zeros (or other values, such as the average of the region) on the border of the input volume. The size of this padding is a third hyper parameter. Padding provides control of the output volume's spatial size. In particular, sometimes it is desirable to exactly preserve the spatial size of the input volume; this is commonly referred to as "same" padding.

The spatial size of the output volume is a function of the input volume size, the kernel field size of the convolutional layer neurons, the stride, and the amount of zero padding on the border. The number of neurons that "fit" in a given volumes then:

$$\frac{W-K+2P}{S}+1.$$

If this number is not an integer, then the strides are incorrect and the neurons cannot be tiled to fit across the input volume in a symmetric way.

Tensorflow:
TensorFlow is a free and open-source software library for machine learning and artificial intelligence. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks. TensorFlow was developed by the Google Brain team for internal Google use in research and production. The initial version was released under the Apache License 2.0 in 2015. Google released the updated version of TensorFlow, named TensorFlow 2.0, in September 2019.TensorFlow can be usedin a wide variety of programming languages, most notably Python, as well as JavaScript, C++, and Java. This flexibilitylends itself to a range of applications in many different sectors.
Tensor Flow computations are expressed as stateful dataflow graphs. The name Tensor Flow derives from the operations that such neural networks perform on multidimensional data arrays, which are referred to as tensors. In Jan 2019, Google announced TensorFlow 2.0. It became officially available in Sep 2019.

K-nearest neighbour (KNN):
K-nearest neighbors (KNN) algorithm is a type of supervised ML algorithm which can be used for both classification as well as regression predictive problems. However, it is mainly used for classification predictive problems in industry.

Implementation in Python:
As we know K-nearest neighbors (KNN) algorithm can be used for both classification as well as regression. The following are THE recipes in Python to use KNN as classifier as well as regressor

KNN as Classifier
First, start with importing necessary python packages −
import numpy as np
import matplotlib.pyplot as plt import pandas as pd

Next, download the iris dataset from its weblink as follows −
path = "https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data

Next, we need to assign column names to the dataset as follows −
headernames = ['sepal-length', 'sepal-width', 'petal-length', 'petal-width', 'Class']

Now, we need to read dataset to pandas dataframe as follows −
dataset = pd.read_csv(path, names = headernames)
dataset.head()

Data Preprocessing will be done with the help of following script lines.
X = dataset.iloc[:, :-1].values y = dataset.iloc[:, 4].values

Next, we will divide the data into train and test split. Following code will split the dataset into 60% training data and 40% of testing data −
from sklearn.model_selection import train_test_split X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.40)

Next, data scaling will be done as follows −
from sklearn.preprocessing import StandardScaler scaler = StandardScaler()
scaler.fit(X_train)
X_train = scaler.transform(X_train) X_test = scaler.transform(X_test)

Next, train the model with the help of KNeighborsClassifier class of sklearn as follows −
from sklearn.neighbors import KNeighborsClassifier
classifier = KNeighborsClassifier(n_neighbors = 8)
classifier.fit(X_train, y_train)

At last we need to make prediction. It can be done with the help of following script −
y_pred = classifier.predict(X_test)

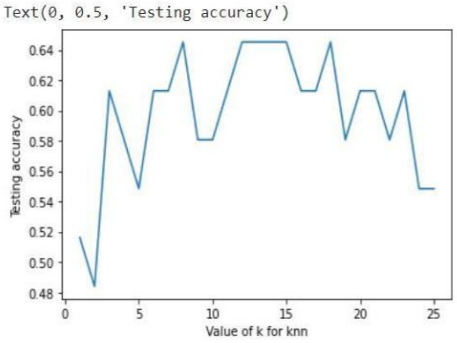

Fig.3 Graph to determine value of K in KNN

Support Vector Machine (SVM)

Support vector machines (SVMs) are powerful yet flexible supervised machine learning algorithms which are used both for classification and regression. But generally, they are used in classification problems. An SVM model is basically a representation of different classes in a hyperplane in multidimensional space. The hyperplane will be generated in an iterative manner by SVM so that the error can be minimized. The goal of SVM is to divide the datasets into classes to find a maximum marginal hyperplane (MMH).

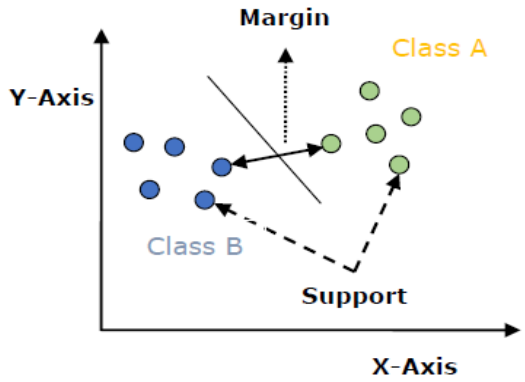

Fig.4: SVM

The main goal of SVM is to divide the datasets into classes to find a maximum marginal hyperplane (MMH) and it can be done in the following two steps

- First, SVM will generate hyperplanes iteratively that segregates the classes in best way.
- Then, it will choose the hyperplane that separates the classes correctly.

For implementing SVM in Python we will start with the standard libraries import as follows –

```
import numpy as np
import matplotlib.pyplot as plt from scipy import stats
import seaborn as sns; sns.set()
```

Next, we are creating a sample dataset, having linearly separable data, from sklearn.dataset.sample_generator for classification using SVM –

```
from sklearn.datasets.samples_generator import make_blobs
X, y = make_blobs(n_samples=100, centers=2, random_state=0, cluster_std=0.50) plt.scatter(X[:, 0], X[:, 1], c=y, s=50, cmap='summer');
```

VII. EXPERIMENTAL RESULTS

After the training of the model, some predictions were made on the testing data using the model for breed identification.

Fig.: 5

Fig.: 6

Fig.5 and Fig.6 shows the given outputs of the predictions of the CNN model. In the Fig.5 it is observed that a picture of Bernese mountain dog is given to the model and the model identifies the breed correctly. In Fig.6 it is observed that a picture of Labrador retriever is given to the model and the model identifies the breedcorrectly.

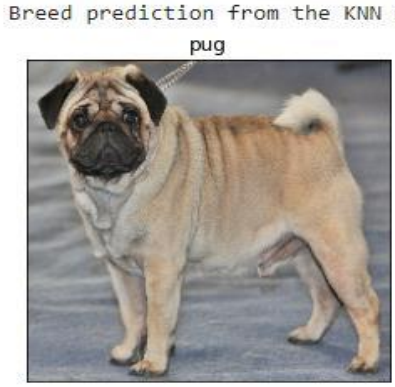

Fig.: 7

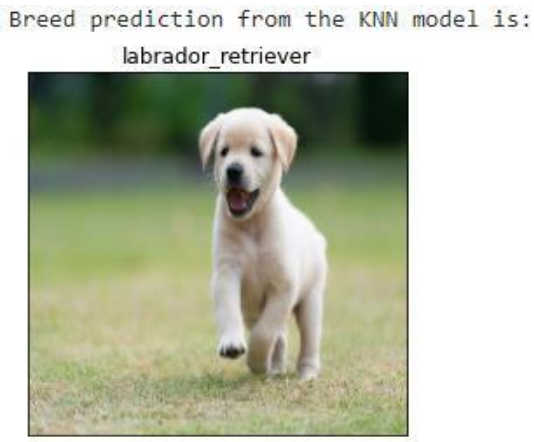

Fig.: 8

Fig.7 and Fig.8 shows the predictions of dog breeds using the KNN model. In Fig.7 the picture of Pug is given to the model and the model predicts the image correctly. Then in Fig.8, the picture of Labrador retriever is predicted correctly using the KNN model.

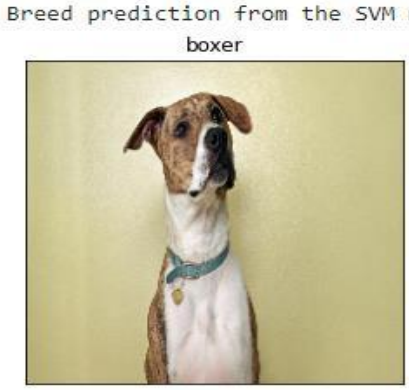

Fig.: 9

Fig. 10

Similarly, Fig.9 and Fig.10 shows the output of the predictions using the SVM model. In Fig.9 the picture of Boxer is predicted correctly using the SVM model and in Fig.10 shown below, the prediction of German Shepherd is predicted correctly using the SVM model.

Some predictions were made on the data for age detection of dogs using all the three models. Fig. 11, Fig. 12 and Fig.13 shows the given outputs of the predictions.

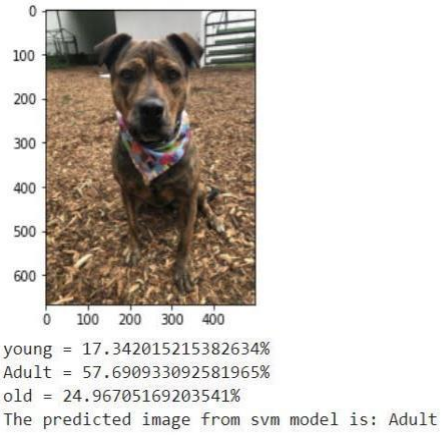

Fig. 11

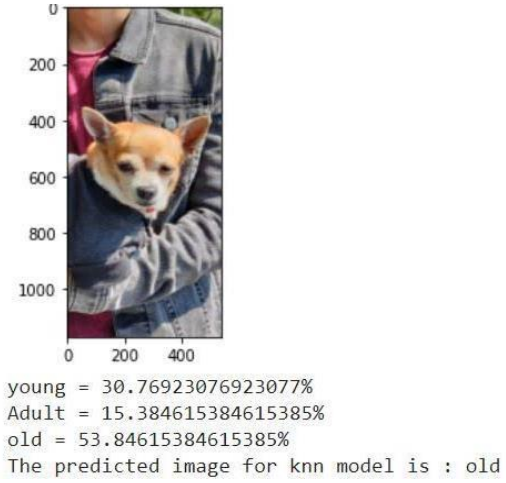

Fig. 12

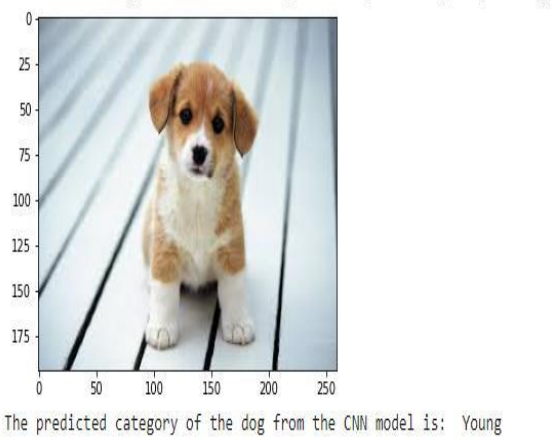

Fig. 13

In Fig.11, the image is predicted as adult from the SVM model as the adult category has the highest accuracy. Then In Fig.12, the image is predicted as old from the KNN model as the old category has the highest accuracy. In Fig.13 the image is predicted as young from the CNN model.

The comparison of all the three models; CNN, KNN and SVM for breed identification and age detection is shown in the following table:

	Breed (Accuracy)	Age (Accuracy)
CNN model	97.81%	77.42%
KNN model	83.4%	64.43%
SVM model	80%	54.6%

VIII. CONCLUSION

This machine learning model will help in identifying the various breeds of dogs as well as their age accurately. It can ease the task of remembering 90+ different breed of dogs discovered until now.

Also, it can became the first ever application for age determination of various dogs and still working is going on to increase the accuracy rates.

IX. ACKNOWLEDGMENT

We wish to thank our parents and friends for their support and encouragement throughout the progress of the project work and we would also like to thank our guide Professor Dr. Ankita Malhotra for guiding throughout the project work.

REFERENCES

[1] Z. Ráduly, C. Sulyok, Z. Vadászi, and A. Zölde, "Dog Breed Identification Using DeepLearning, "2018 IEEE 16th International Symposium on Intelligent Systems and Informatics (SISY), 2018, pp. 000271-000276, doi:10.1109 /SISY. 2018.8524715.

[2] M. V. SaiRishita and T. Ahmed Harris, "Dog Breed Classifier using Convolutional Neural Networks," 2018 International Conference on Networking, Embedded and Wireless Systems (ICNEWS), 2018, pp.1-7, doi:10.1109/ICNEWS. 2018. 8903980.

[3] A. Varshney, A. Katiyar, A. K. Singh and S. S. Chauhan, "Dog Breed Classification Using Deep Learning,"2021 International Conference on Intelligent Technologies(CONIT), 2021, pp.1-5, doi:10.1109/CONIT51480.2021.9498338.Intelligent513,doi:10.1109/ICISS49785.2020.9315871.

[4] P.Prasongand K.Chamnongthai,"Face-recognition-based dog-breed classification using size and position of each local part, and PCA," 2012 9th International Conference on Electrical Engineering /Electronics, Computer, Telecommunications and Information Technology, 2012, pp.1-5, doi: 10.1109/ECTICon.2012.6254212.

[5] C. Wang, J. Wang, Q. Du and X. Yang, "Dog Breed Classification Based on Deep Technologies (CONIT), 2021, pp.1-Intelligent Learning," 2020 13th International Technologies (CONIT), 2021, pp.1-Symposium on Computational Intelligence and 5,doi:10.1109/CONIT51480.2021.9498338.

[6] R. O. Sinott, F. Wu and W. Chen,"A Mobile Application for Dog Breed Detection and Recognition Basedon Deep Learning," 2018 IEEE/ACM 5th International Conference on Big Data Computing Applications and Technologies (BDCAT), 2018, pp.87-96, doi:10.1109/ BDCAT. 2018.00019.

[7] Borwarnginn, K. Thongkanchorn, S. Kanchanapreechakorn and W. Kusakunniran, "Breakthrough Conventional Based Approach for Dog Breed Classification Using CNN with Transfer Learning," 2019 11th International Conference on Information Technology and Electrical Engineering (ICITEE), 2019, pp.1-5, doi:10.1109/ICITEED. 2019.8929955. W.-K.Chen, LinearNetworks and Systems, Belmont, CA:W adsworth,1993, pp. 123-135.

[8] M. V. SaiRishita and T. Ahmed Harris, "Dog Breed Classifier using Convolutional Neural Networks," 2018International Conference on Networking, Embedded and Wireless Systems (ICNEWS), 2018, pp.1-7, doi: 10.1109/ ICNEWS. 2018.8903980.

[9] B. K. shah, A. Kumar and A. Kumar, "Dog Breed Classifier for Facial Recognition using Convolutional Neural Networks," 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), 2020, pp.508-Design (ISCID), 2020, pp.209-212, doi: 10.1109/ISCID51228.2020.00053