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Birds Species Identification from an Image using Machine Learning

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ABSTRACT

Now a day some bird species are being found rarely and if they are found their classification is difficult. Naturally, birds present in various scenarios appear in different shapes, colors, sizes and angles from human view. Besides, the images have strong variations to identify the bird species more than audio classification. Also, human can easily recognize the birds through images. So this method uses the Caltech- UCSD Birds 200 [CUB-200-2011] dataset for training as well as testing purpose. By using deep convolutional neural network (DCNN) algorithm an image converted into grey scale format to generate autograph by using tensor flow, where the multiple nodes of comparison are generated. These different nodes are compared with the testing dataset and score sheet is obtained from it. After analysing the score sheet the bird species which has highest score is predicted. Experimental analysis shows that algorithm is accurate between 80% and 90% for bird species identification. Here ML5 library is used. Naturally, birds are in several sizes, shapes, colors, and angles from human perspective. Also, human can acknowledge the birds through the photographs as compared to audio recognition. The humans rarely ready to predict the bird species name with solely the audio of bird voice. Here Caltech-UCSD Birds two hundred [CUB-200-2011] dataset is used for testing purpose. Wherever the multiple nodes of comparison area unit generated by exploitation deep- convolutional neural network (DCNN) algorithmic rule a picture regenerate into gray scale format to get autograph by exploitation tensor flow. These completely different nodes area unit are compared with the testing dataset and score sheet is obtained from it. Once analyzing the score sheet it will predicate the specified bird species by exploitation highest score. Experimental analysis on dataset (i.e. Caltech-UCSD Birds two hundred [CUB-200- 2011]) shows what algorithmic rule achieves.

Index Terms: Bird species classification, Deep Networks, Transfer Learning, Multistage Training, Object Detection.

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1. INTRODUCTION

Identification of bird species is very challenging task and it is often ambiguous. Sometimes professional bird watchers disagree on the species given as an image of a bird. For both humans and computers this is a difficult problem that pushes the limits of the visual abilities. Although different bird species share the same basic set of parts, different bird species can vary dramatically in shape and appearance. Due to variation in lighting and background and extreme variation in pose intra-class variance is high (e.g., flying bird, swimming bird, and perched bird that are partially occluded by branches). The aim of this project is to use the power machine learning to help the bird watchers identify bird species from the images they capture.

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2. DATASET

Caltech and UCSD have gathered data to produce the ”Caltech-UCSD Birds-200-2011 (CUB200-2011)” dataset. The dataset contains 11,788 images of 200 bird species. An online field guide is used to obtain list of species. Images were harvested using Flickr image search and then filtered by showing each image to multiple users of Mechanical Turk.

3. FEATURES

A group of 28 attribute and 312 binary attributes (e.g., the attribute group”belly color” has 15 different color choices) was selected based on an online tool for bird species identification. All attributes are visual in nature. Also they are most pertaining to a color, pattern, or shape of a particular part. Examples of some of these attributes are:

- *has back color::red*
- *has bill shape::cone*
- *has wing shape::pointed-wings*

4. EXPERT SYSTEM ARCHITECTURE

We realized that the essence of the project was to understand the working of different machine learning algorithms. Also we learn which algorithm gives good results. We implement KNN and Naive Bayes in MATLAB and write those implementations. A baseline for future techniques that could be implemented using available libraries can be obtained by looking at the results of these two algorithms.

We observed that libraries like *ML5* allowed us to tweak different aspects of an algorithm, but maybe not to the extent of our own implementation of the algorithm. We faced an inherent trade-off between tweaking ability and the number of algorithms that could be implemented and tested in the time frame of the project. We chose trying out numerous algorithms using the *ML5 Learn* library of machine learning:

1. Naive Bayes

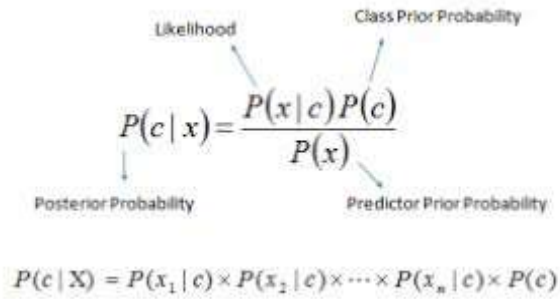

Figure 1: Naïve Bayes

2. Support Vector Machines

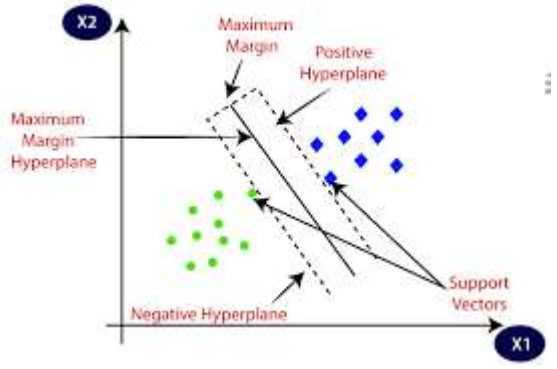

Figure 2: Support Vector Machines

3. K-nearest Neighbors

Figure 3: K-nearest Neighbors

4. Linear Discriminant Analysis (LDA)

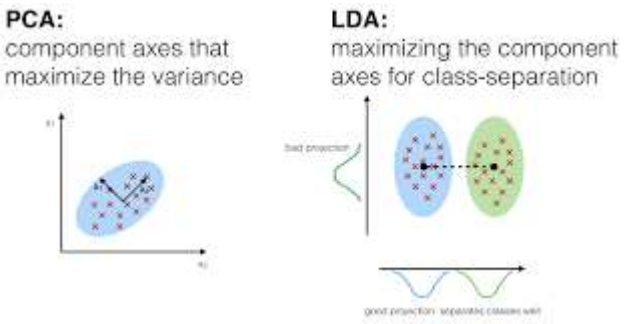

Figure 4: Linear Discriminant Analysis (LDA)

5. Decision Trees

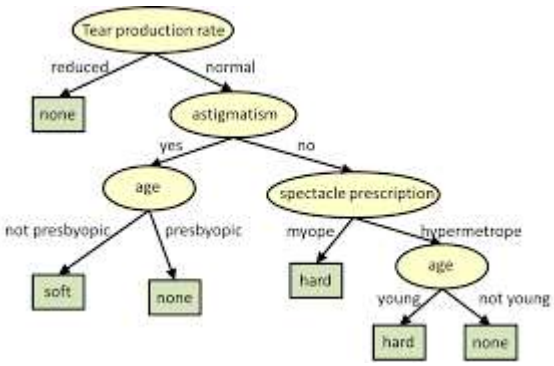

Figure 5: Decision Trees

6. Random Forests

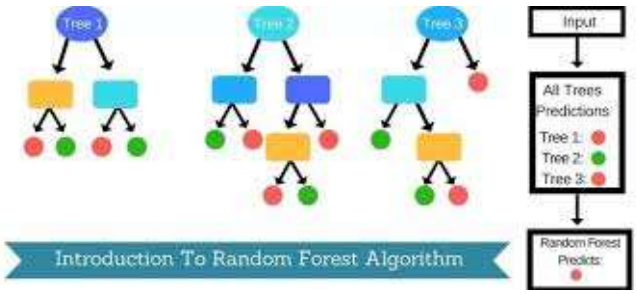

Figure 6: Random Forests

7. One versus Rest classifiers with Logistic Regression

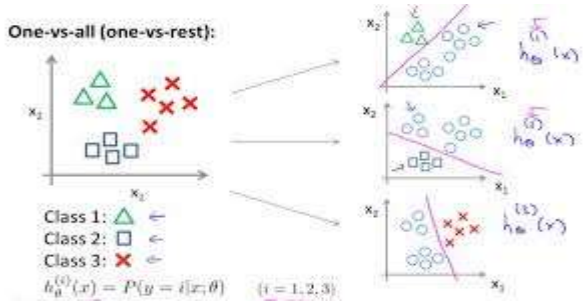

Figure 7: One versus Rest classifiers with Logistic Regression

Best three techniques is chosen based on the results. Various feature selection and feature reduction techniques were used to see if we can improve the accuracy further. We started with changing kernels for SVM - Linear and Radial Basis Functions. Next, we did feature reduction using PCA and applied SVM, Logistic Regression and LDA on the reduced features. We then used feature selection techniques like L1 based method, removing features with low variance, uni-variate feature selection and tree based feature selection. A slight improvement gave us hope and we decided to play with it more. We used PCA for feature reduction followed by feature selection to obtain a new feature data. We implemented LDA, Logistic Regression and SVM on this data. Thus, the accuracy is improved further. In the end, we tried including the certainty values of features into our model, that is, we converted the original binary feature data into 8 discrete values between 0 and 1 based on the certainty. No significant change was observed when algorithms are run on this data

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5. PROPOSED WORK

The actual flow of the proposed system is represented using figure 8 below. A trained dataset is required to develop such system for classification of an image. Trained result and test result are two parts included in trained dataset. The dataset has to be retrained to achieve higher accuracy in identification using retrain.py in Google Collab.50000 steps are taken into consideration while making training dataset. Higher the number of steps in the training dataset higher is its accuracy. The accuracy of training dataset is 93%. The testing dataset consists of nearly 1000 images with an accuracy of 80%. Further, dataset is validated with an accuracy of 75% and thus performance of system is improved.

Whenever a user will upload an input file on website, the image is temporarily stored in database. This input file is then feed to system and given to CNN where CNN is coupled with trained dataset. A CNN consists of various convolutional layers. Various alignments/features such as head, body, color, beak, shape, entire image of bird are considered for classification to yield maximum accuracy. Each alignment is given through deep convocational network to extract features out from multiple layers of network. Then an unsupervised algorithm called deep learning using CNN is used to classify that image.

Further, the image is classified pixel by pixel by using grey scale method. These features are then aggregated and forwarded to classifier. Here, the input will be compared against the trained dataset to generate possible results. During classification, an autograph is generated which consist of nodes that ultimately forms a network. On basis of this network, a score sheet is generated and using this score sheet output will be produced.

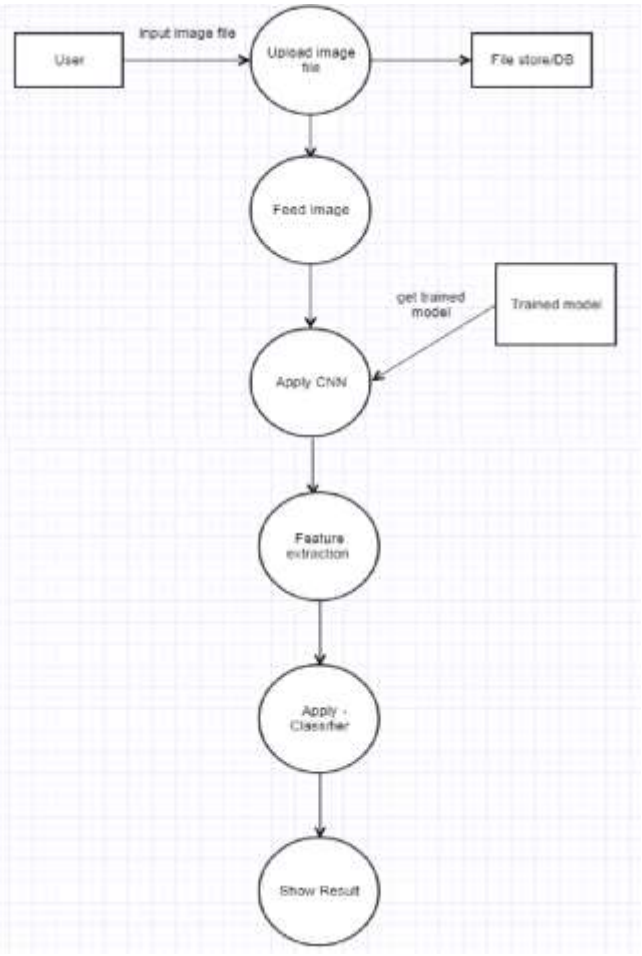

Figure 8: Flow of the system

6. APPLICATION

While several species recognition systems have used audio, more recently, recognition systems have focused on the application of computer vision techniques.

- Studies related to Other Species :

  While computer vision applications to bird species represent the most relevant existing works, there have been a number of other studies which have been applied to bats and which address similar problems and challenges.

- Application of computer vision techniques to species classification :

  Unlike bats, which are typically filmed in low-light, the automated monitoring and classification of other species is able to make wider use of appearance features (such as colour).

- Bird Species Classification using Appearance Features:

  Whilst Cullinan et al. (2015), and Matzner et al. (2015) mentioned above have attempted to use motion features to differentiate between small numbers of species, all other existing works concerned with the automated classification of birds use appearance features derived from a single image of an individual bird.

7. DISCUSSION

With basic implementation of Naive Bayes and KNN in MATLAB, We initially observed low accuracy. We then observed improved accuracy with library implementations of SVM, LDA and Logistic Regression. Feature selection and feature reduction improved the accuracy to 53%. We believe such an accuracy for a 200 class classification problem is fairly decent.

Table 1: Comparison with related published work

Feature Extraction Method	Learning Method	Percentage Accuracy
MTurks	Logistic Regression	53.65
Computer Vision	SVM	51.0
Computer Vision	Logistic Regression	65.0
Computer Vision	SVM+CNN	75.7

8. FUTURE WORK

1. We implemented Neural Networks and when we ran it on our machine for just 5 hidden neurons, it went out of memory and could not complete. So, we can try to run Neural Networks on high performance computing machines.

2. Automatic feature extraction uses computer vision algorithms.

3. For identification of a bird in real time on clicking its photo, we can develop an Android/iOS application.

9. RESULTS

We started by training and testing our algorithms on the complete data set to start with. Later we randomly separated the data set into training data and test data so that we had samples from each class. 70% of the data was used as training data and 30% was used as test data. The following figures and tables show the results we observed on implementing algorithms as mentioned in the above section.

Table 2 and table 3 shows the training versus testing accuracy for different learning methods that we

implemented. Figure 2 shows the testing accuracy using different techniques on three of the learning methods - LDA, SVM and Logistic Regression.

We can also identify other species such as vegetables, animals, plants, etc. The probability to recognize a bird is less than an audio recognization.

Table 2: Training vs Testing Accuracy of different techniques

Table 3: Training vs Testing Accuracy of different techniques

Method	Using PCA	Using Feature Selection	Using PCA + Feature Selection
Naive Bayes			
KNN			
Decision Trees			
Random Forests			
LDA	47.81	47.7	47.38
SVM	48.74	49.11	46.93
Logistic Regression	53.31	51.02	53.65

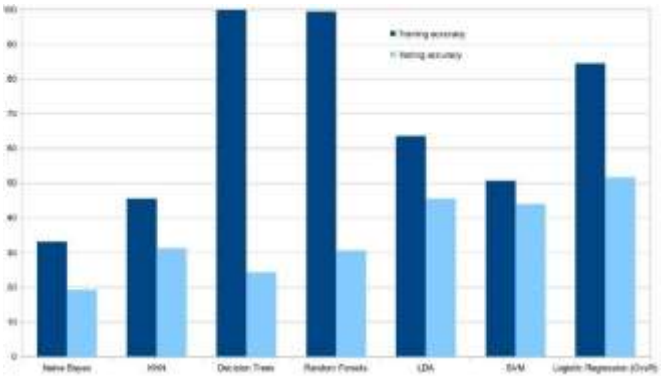

Figure 9: Testing accuracy with various techniques

10. ADVANTAGES

- It is easy to identify any species of birds and animals by using ML or android application.
- The total identification of birds can be seen by on android app.
- The lengthy process by searching each birds on google is reduced.
- As image based classification systems are improving the task of classifying.
- Anywhere availability.

Method	Training Accuracy	Testing Accuracy	Using certainty metric
Naive Bayes	33.07	19.22	
KNN	45.43	31.18	
Decision Trees	99.83	24.35	
Random Forests	99.39	33.58	
LDA	63.56	45.44	46.73
SVM	50.67	43.91	48.15
Logistic Regression	84.42	51.61	52.42

- User friendly interface.
- It takes less time to execute.
- Any species can uploaded and get the appropriate result.

11. DISADVANTAGES

- SVM has some disadvantages like it requires intervention of kernel at some point which is difficult.
- Awarness of Internet access.
- This application does not work in iphone.
- For editing and deleting the content of datasets, all the dataset have to changed
- By considering a single parameter will not yield an accurate result.

12. CONCLUSION & FUTURE WORK

In this paper, we have proposed a method to both localize and classify the species of the bird from high-definition photographs taken from camera by using a end-to-

end approach with Mask R-CNN, transfer learning and multi-stage training. we can identify the bird species using image as well as an audio.

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