CLASSIFICATION OF BIRD SPECIES USING DEEP LEARNING

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Research titled **"Classification Of Bird Species Using Deep Learning "** submitted by **Md. Sharifuzzaman Apu** to the Department of Computer Science and Engineering, Faculty of Science and Information Technology, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science & Engineering and approved as to its style and contents. This Presentation has been held on 24 January 2024.

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DECLARATION

We hereby declare that this research has been done by us under the supervision of **Dr. Fizar Ahmed, Associate Professor, Department of Computer Science and Engineering**, Faculty of Science and Information Technology, Daffodil International University. I also declare that neither this research nor any part of this research has been submitted elsewhere for the award of any degree.

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ABSTRACT

Many bird species are rare to find these days, and even when they are, it might be difficult to classify them. For example, birds have different sizes, shapes, and colors depending on the situation, and they also have different perspectives as anthropoid observers. Without a doubt, the images show altered conditions that should be recorded using image recognition software for bird species. It is also a calm way for people to identify the birds in the pictures. This study presents a variety of image processing methods for identifying various bird species. The goal of the study is to identify the kind of bird using 11 classes of bird's photos. Several algorithms and techniques have been developed to reliably identify and categorize photos according on whether or not birds are present. Eleven different class types were used in this experiment, including deep learning-based models including the Black Drango, Common Myna, Common Tailor Bird, Crow, Dove, Greater Coucal, Pigeon, Sparrow, Kingfisher, Magpie, and Heron. To predict and identify bird species, five models—MobileNetV2, DenseNet169, InceptionV3, VGG16, and VGG19—are used. Lastly, two distinct performance assessments are used to evaluate the technique's outcomes. The first accuracy set, assessment of performance for bird species conditions, employs four probable final results: TP, TN, FP, and FN. The accuracy of every kind of bird in error scenarios is then examined using these models. With the 94.92% accuracy rate of the MobileNetV2 technique, my proposed solution paves the way for autonomously recognition of various species in birds. To create a web prototype, the MobileNetV2 network is ultimately used for classification to identify different species of birds.

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CHAPTER 1

Introduction

1.1 Introduction

Bangladesh is home to a wide variety of birds. Nearly all of the birds nearby have names that we are aware of. Birds are incredibly significant to our culture. They are heard chirping in many places, like as towns and villages, and many individuals are able to identify them by their noises. The sounds of birds are a common source of passion and inspiration for artists, authors, and composers worldwide. Many bird species are rare to find these days, and even when they are, it might be difficult to classify them. Because they adapt swiftly to ecological changes, birds aid in our ability to distinguish between the various living forms that inhabit our planet. However, since birding technology has grown so costly, gathering data on species of birds needs a lot of human labor. In this situation, a strong framework is required to prepare enormous amounts of bird data and to be a useful tool for scientists, lawmakers, and other stakeholders. In this sense, the bird species designation certificate has made significant progress in determining the kinds of positions that various bird images have. Bird species identification is the process of identifying a bird's category from pictures. It is possible to identify different species of birds using images, sounds, or videos. The technique of audio processing allows for recognition by recording the distinct sound signals of various birds. However, the outcomes when analyzing such data have proven to be progressively more complex because of the mixed noises present in the environment, such as real-world items and creepy crawlers. Ornithologists have been dealing with a variety of difficulties for decades when it comes to species identification of birds.

Birds' features and attributes are studied by ornithologists, who differentiate them based on factors like as biology, ecological effect, and life in the atmosphere [1]. Linnaeus uses the following categories to help ornithologists identify birds: Phylum, Kingdom, Order, Class, Family, Species. In order for the machine to identify a bird using a picture, it must first identify the important portion of the birds and exclude any irrelevant background. For humans, it is simple to notice. We must gather a large amount of data in order to train the system to distinguish different types of birds. Researchers have expressed interest in finding a solution in previous years. After reviewing earlier research, we concluded that there hasn't been enough progress achieved in deep learning to warrant further advancements in bird categorization. We thus wish to investigate this issue in the hopes of

coming up with a good solution. We concentrated on automated species identification of birds in our situation in this research.

Several DL methods may be applied to determine the bird categorization. The suggested paradigm includes picture acquisition, preprocessing, extraction of segmentation features, and classification. For most of a process sequence, deep learning (DL) and computational analysis of images provide a variety of approaches. For comparing drawings that may be used to correctly identify bird species, several procedures are necessary. Getting and scanning damaged photos in JPG, PNG, and Tiff types of files is the first step in teaching the computer. The first image the algorithm retrieves is the one with the birds. The initial JPG file type's energy density was then altered once again.

As mentioned before, a self-governing computer-based technique for classifying birds. Among the techniques for classifying birds are image processing, big data, and the Internet of Things. The DL methods are also shown to be advantageous for this purpose. The deep learning technique allows the machine to learn on its own and generate conclusions. Unsupervised learning, self-taught studying, and reinforcement learning are the three categories of neural networks that may be used for deep learning. Many sophisticated deep learning techniques were taught to recognize bird categorization in this study; these techniques will also complete the classification assignment.

The topic of this article is bird species. After image recognition, many processing strategies are used to address the unique challenges posed by the real bird photos in order to accomplish several objectives. Photo analysis can be used to achieve the following objectives:

- Classifying photographs of birds by species.
- Applying the measurements from DL models to determine the bird's severity.
- Developing a web prototype to identify various bird species.

1.2 Objectives

As a result, when the next generation develops up and walks outside, they will observe different kinds of birds with similar colors and assume that all birds are the same. But because they no longer possess appropriate information, they just share the same colorings and unique species, and

they will never understand the differences between them. So long as they have the right devices, they can capture photos of every bird, and as soon as we build a mobile app, the app is going to do the same. It will tell us the species of bird and, in the event that it cannot find a particular bird among the data set, show us some birds that are somewhat similar to one another.

Because they can easily connect with nature and don't have to spend time, they are becoming more knowledgeable and dislike going outside. Modern times have seen a significant improvement in technology. Innovation can help address any problem. Using deep learning approaches to diagnose bird categorization was the main objective of this effort. Accurately classifying various bird species is the main goal, which is to predict the birds. My aim is to categorize bird photographs depicting different species using deep training and a photo analysis method. As a result, I became able to establish the following goals:

- To use deep learning to predict the eleven species of birds.
- To compile information for bird forecasting.
- Acquiring a comprehensive understanding of the domains related to deep learning.
- Applying a range of strategies to enhance outcomes.

1.3 Motivation

We utilize computers, smartphones, and the internet extensively since we are a contemporary generation. Rather of venturing outside, we choose to stay inside and use the internet to learn and comprehend the world. In the past, there was a time when our generation spent a lot of time outside, engaged in adventurous activities, spent time in nature, saw a lot of birds, and learned a lot about them. Nowadays, people are so preoccupied with their own lives that they seldom venture outside, which is a great way to spend time in nature. How then do they interpret and evaluate an animal? They can only understand them by watching television and by looking at their photos and videos on the internet.

My motivation for working in this subject and using DL and AL to identify bird species came from this. I gave it some thinking, but I was unwilling to come to terms with an idea for the paper that would meet the requirements of the research. So I went to one of my favorite professors for

assistance. It was advised that since there are several bird species in the current habitat, I look into a similar concept to this issue. This is the reason I chose to write a paper on " **Classification Of Bird Species Using Deep Learning Web Application**." In an effort to develop my own, I also see that society is making use of new discoveries to advance and that scholars are delving further into these subjects. The following motivated us to do this kind of research-based work. Deep learning is essential because artificial intelligence has connected everything around me.

1.4 Rationale of the study

There has undoubtedly been progress in domains like as object identification and image processing, where countless studies have been conducted. There are yet not many completed articles on the topic of " **Classification Of Bird Species Using Deep Learning Web Application**." As such, a range of algorithms and categorization strategies are used in my research. For this topic, I created a custom model and predictor. With careful planning, I was able to complete the work in a timely manner.

Image processing is a broad process with several subcategories, including data reduction, measurement processing, picture improvement, restoration, and augmentation. Digital photos have the advantage of requiring less storage space. Pictures aren't flawless. Images may include flaws brought on by issues with the digitization process. Photographs that are damaged can be restored using image enhancement methods. Deep learning algorithms are another method that may be used to identify them.

1.5 Research Question

This study has been completed with a great deal of enthusiasm and effort. I had a really hard time doing this task. The development of a precise, workable, and fair system is hampered by a number of issues. In order to investigate this matter further and examine these ideas in greater detail, scholars are interested in learning the responses to the following significant queries:

- Can I use raw image data for my deep learning research?
- Is it OK to accept raw data?
- Is it possible to use a deep learning approach to preprocess the data first?

- Does this research provide reliable findings on birds?
- Can the result identify every bird?
- How advantageous would it be to assume that results provide 100% accuracy?

1.6 Expected Outcome

Some circumstances have been included in this portion as they have the most fundamental intended consequence of mine. Various methods of classification are being employed to classify the various bird species in order to facilitate further research and to predict the actual prognosis of a bird. The goal of this research-based project is to offer a comprehensive, efficient methodology or strategy that recognizes various bird species photos using a prediction algorithm developed on an unprocessed dataset. Consequently, the following is a list of each of the previously mentioned expected outcomes:

- I'll examine different species of birds to show that they exist.
- A deeper comprehension of the procedure for classifying bird species using DL.
- Using out-of-date image data, I want to compare my results with those of earlier investigations.
- Selecting the CNN model with the greatest DL performance for classifying bird photos according to the various species in the data.

1.7 Layout of the Report

The first chapter provided an overview of the study's methodology, including its objectives, sources of inspiration, purpose, and expected outcomes. The overall framework of the inquiry is also described in this section.

What has previously been accomplished in this sector is covered in Chapter 2. The final segment of the second chapter keeps illustrating the depth that results from the limitations of this subject. The main challenges or limitations to the research are briefly discussed. This chapter describes the

challenges that must be conquered in order to finish the mission, discusses the subject, and includes sections on related works.

The conceptualization of this research endeavor is explained in Chapter 3. More details on the statistical techniques applied to address the investigation's theoretical component may be found in this chapter. This chapter also provides examples of the procedural methods to deep learning technology. The next chapter describes the process for obtaining datasets and the data preparation system. Confusion matrix assessment is also included in the latter portion of this subdivision in order to assess the method and show the accuracy tag of the classifier. When using deep learning approaches, it is crucial to ensure true accuracy by including implementation analysis. This section covers a number of topics, including the study's subject and instruments, workflow, data collection process, data processing, suggested model, training mode, and the operational criteria that had to be met in order to build this project. Each technique used in this study comes with a thorough description of all single dL Techniques and classifications that were used.

Chapter 4 presents the experimental results, performance evaluation, and result discussion. A few test photos are included in this chapter to aid in the project's implementation. A review of the use of methods of deep learning concludes this chapter.

Chapters 5 and 6 included an overview of the study, information on planned activities, and a discussion of the findings. To show that the project report complies with all standards, this chapter offers a verified example. Impact on the Environment and the Entire Society: The chapter ends by pointing out the inadequacies of my current initiatives, which might influence future employees with comparable goals.

CHAPTER 2

Background

2.1 Introduction

This section's main components include the research synopsis, challenges, pertinent literature, and study findings. Under "Associated Works," I'll examine research articles written by other writers and discuss the connections between their concepts and accuracy and approach. In the section that focuses on similar works, I will discuss the articles, approaches, and credibility of other scholarly publications that are relevant to my research. A summary of my related work will be included in the section on research descriptions. I describe how I overcame each difficulty I ran into while doing the research and how I increased the accuracy of each stratum during the difficult parts. Everything has already been talked about. The primary goal of creating an identifying website is to raise public knowledge of birding, identification, and bird watching, particularly with regard to the birds of Bangladesh. It also meets the requirement to streamline the process of identifying birds, which facilitates bird viewing. Convolutional neural networks are the method utilized in the experimental setting (CNN). For picture recognition, feature extraction is used. The technique is adequate for classifying bird photos and extracting characteristics.

2.2 Related Works

A great deal of work has gone into utilizing photos to categorize different kinds of birds. Three categories exist for classifying images: semi-supervised, supervised, and unsupervised classifications. A picture and matching label are needed to train a classification model in the supervised classification technique. In unsupervised classification, which is the opposite of supervised classification, a picture may be classified without the need for training. Using both supervised and unsupervised methods is possible with the Semi Supervised methodology. The discussion of several methods for identifying bird species that have been studied by numerous researchers may be found below.

Machine learning algorithms have advanced to the point that picture recognition is now done with their help. The support vector machine, or SVM, method is employed as a recognition technique

in [2]. Two distinct photos were classified using a decision tree. Data mining methods can be used to tackle the classification issue. In [3], data mining methods were used to identify the species of birds.

Sound-based categorization has become more and more common in recent years. Numerous pieces of art have been created based on the sounds of different bird species. [4] suggested an auditory classification method for classifying different kinds of birds. [4] demonstrates a novel approach to deep learning and voice recognition through the use of closest neighbor matching or decision trees with extracted instruction. Supervised learning was used to complete all of these sound-based projects. [5] investigated the possibility of utilizing unsupervised learning to identify the species of birds based on acoustic samples in order to overcome the challenge. To acquire approximation, note models, an unsupervised technique is utilized.

An Investigation on Deep Learning Applied to Autonomous Bird Identification [6] They have demonstrated that the algorithm is appropriate for application in the real world and have constructed a non-deep CNN for picture categorization. The main function of the image classification was achieved without the use of the radar's limits, which provide additional and useful information for the classification and have the power to rectify an incorrect classification. The test site will complete data collecting, providing a sizable data set.

Deep learning techniques for the detection flying birds in the wild [7], they have provided a comparative analysis of the most advanced deep learning techniques for identifying birds in the field, including YOLOv2, the latest version of and Mask R-CNN. The dataset from the pre-trained model has been used. F-score was employed as a presentation metric to measure YOLOv2, YOLOv3, then Mask R-CNN scores, in that order. Mask R-CNN and YOLO v2 are associated to YOLO v3 more quickly. In their results, YOLO v3 surpasses YOLO v2, but only marginal improvements are seen when Mask R-CNN is completed.

In this study, an image processing algorithm that detects birds was used to construct a model using techniques for identifying birds that are predatory in aquaculture settings [8]. They created and evaluated three image processing techniques: template matching, artificial neural networks, and

image morphology. The photos were trained for three minutes using the ANN model. Nevertheless, upon testing the photos, quick results were obtained. A comparative analysis of image processing methods for identifying birds.

As biotechnology advances [9], birds may now be detected using both pattern matching and Viola-Jones algorithms. As long as the classifier can be trained with a large number of similar positive pictures, the Viola-Jones approach can effectively handle nearly any item.

In conclusion, there is further work to be done on computer-aided categorization and detection of bird species. Obtaining an evaluation that is quick, precise, and reasonably priced is still dependent on the qualifications of the radiologist, though. The literature makes it clear that earlier research was inaccurate and unreliable. Furthermore, unlike the suggested method, there is no systematic technique to identify the birds fast. In order to utilize a web application to classify bird species, I employed five different models—InceptionV3, VGG16, VGG19, DenseNet169, and MobileNetV2—to forecast and recognize Birds photos.

2.3 Research summary

I spent a lot of time researching the many tactics that society offers. Using images, a deep learning-based system is being used to recognize bird species and categorize each species in five distinct ways. Utilizing my combined actual and online dataset, I employed several techniques. In this instance, the primary information source was the dataset I put up from raw data from many location photos of birds. I'll be able to evaluate the validity of the five techniques I employed and research elements like the significance of the additional data I supplied utilizing the same source. The new dataset is an identical duplicate of the earlier dataset it was joined with. By classifying them into related categories and classes using tags, it is feasible to explain what they represent. My feature extraction techniques employed CNN and DL approaches for categorizing bird species using online apps, with Python serving as my main engine of choice.

2.4 Scope of Problem

For our project, real-time data was required. In future generations, we will be working with real-time data. However, getting all of the current information from a bird with different kinds of photos is a very difficult problem.

2.5 Challenges

Managing visual data proved to be too difficult, therefore the primary difficulty in the investigation is not only digesting the information but also acquiring it. It was difficult for us to learn about this issue without going back to the same location frequently to collect actual bird photos and review the web information. My dataset was standardized and cleaned using a range of methods and resources. It took my machine an extended amount of time to process the huge amounts of data with numerous levels and different epoch scopes. As a result, I had to put up with a lengthy wait for the findings. I was compelled to acquire datasets from actual fields in order to gather photographs because earlier datasets on this subject did not fairly represent my understanding after several tests and field data gathered from different places for picking birds images. I had never done research before, so I had to put a lot of effort into figuring out the best strategies to do the task quickly. Similar to the last example, using DL models for classification led to preprocessing issues with the image data.

CHAPTER 3

Research Methodology

3.1 Introduction

The part that follows goes into depth on the methods and approach I used to classify the several species types I looked at. The main parts are the collection and analysis of the data as well as the proposed model, which is further clarified by the relevant estimation, graph, table, and explanation. By splitting and forecasting utilizing my actual field, the combined online and offline information, and the DL categorization framework, it yielded the greatest accuracy for the study. In the final portion of the chapter, I provided a summary of my statistical presumptions. I built my representations for this experiment using eleven distinct class types. Although birds can suggest many other sorts of species, I concentrated my research on eleven primary classes of birds: Black Drango, Common Myna, Common Tailor Bird, Crow, Dove, Greater Coucal, Pigeon, Sparrow, Kingfisher, Magpie, and Heron. Eleven distinct class types used all of the participant photos to deliver teaching in the current study.

3.2 Study Subject and Equipment

A studied issue is an area of research that is being looked at and investigated to clarify ideas for creating models, accomplishing objectives, gathering information, managing, providing instruction, and enhancing performance. I go over my methods and instruments for measuring. Scikit-learn, OpenCV, and other programs were developed using NumPy in conjunction with the programming language Python and Microsoft software. The infrastructure of Google Co Lab is only utilized for testing and training. Python programmers at Google's Colab may write deep learning and data mining techniques.

Used Libraries:

- **Matplotlib:** The most prominent of Matplotlib's visualization features is Py-plot graphing, a collection of functions. It helps with constructing forms and helps identify lines within a plot and define the borders of a scheme, among other things.
- **NumPy:** One popular way to work with matrix in Python is to use the NumPy module. It covers matrices, the Fourier transform, and the foundations of linear algebra. The NumPy module for Python offers resources and tools to facilitate manipulation of matrices of various sizes. NumPy allows arrays to be built correctly and scientifically. To put it simply, calculations are performed using the NumPy Python library. It also refers to it as "a variety of sorts of Python."

- **Scikit-learn:** This tool for predictive data analysis is practical and user-friendly. Open-source software is available for anybody to use and modify to their own specifications. Through expansion, Matplotlib, NumPy, and SciPy were used.
- **Seaborn**: This well-liked data visualization tool is recognized for its history of integrating with matplotlib and for being an easy-to-use tool for creating visually striking and compelling data representations.
- **CV2:** To solve computer vision issues, a set of Python bindings known as OpenCV-Python was developed. It also makes it feasible to identify people, objects, and even scribbled inscriptions by analyzing images and movies.
- **Job-lib**: This more efficient method of avoiding repeating the same computation might save a significant amount of money and time.
- **H5py:** The h5py package offers a Python wrapper for native HDF5 data. Large amounts of quantitative data may be easily handled and stored in HDF5 with the help of NumPy.
- **OS:** Producers can use the range of tools provided through the Python OS component to interact with the application that is an essential part of the system on which they are working on.
- **TensorFlow**: This downloadable Python mathematics framework makes the creation of neural networks and self-learning techniques easier and faster.

3.3 The process of work

There are a number of methods or strategies that may be utilized to figure out how to evaluate the data that was used in this inquiry. The present study used a multi-step technique comprising model selection, creation, data collection, model expansion and improvement, and production.

Step 1: Data Collection: To create my own trustworthy data collection, I collected unprocessed statistical data from several sources and from the internet. Since it is difficult to locate the dataset and obtain data for the specific species using bird photographs of the following classes, there isn't a large, full dataset accessible in this area.

Step 2: Data Preprocessing: Every type of data was gathered in its unprocessed state from many sources and managed independently, with internet data integrated to generate a dataset. Numerous data sets may have errors and noise. Technically speaking, I absorb this information first before using the selected data set to move on to the next stage.

Step 3: Datasets preparing: After every class was analyzed, the findings were cropped and kept expanding. For it to function, I had to add data and resize. Because I was worried about overfitting, I limited the total amount of increases I made to the largest and most suitable.

Step 4: Selecting model: After making your selection, use the provided data to train and assess the selected model in order to increase accuracy. DL uses a wide variety of models. Several versions of the concept were tested using my equipment before determining which configuration to use for data calculating accuracy.

Step 5: Performance Evaluation: This part covers all of the findings. With testing and training, these strategies gave us an inadequate degree of reliability for the following two courses. Confusion matrix, recall, efficiency, and f1 assessment graphic were also generated, along with an online tool for diagnosing bird species photos.

Step 6: Concluding Remarks and Upcoming Initiatives: The section after this has a development schedule and overview.

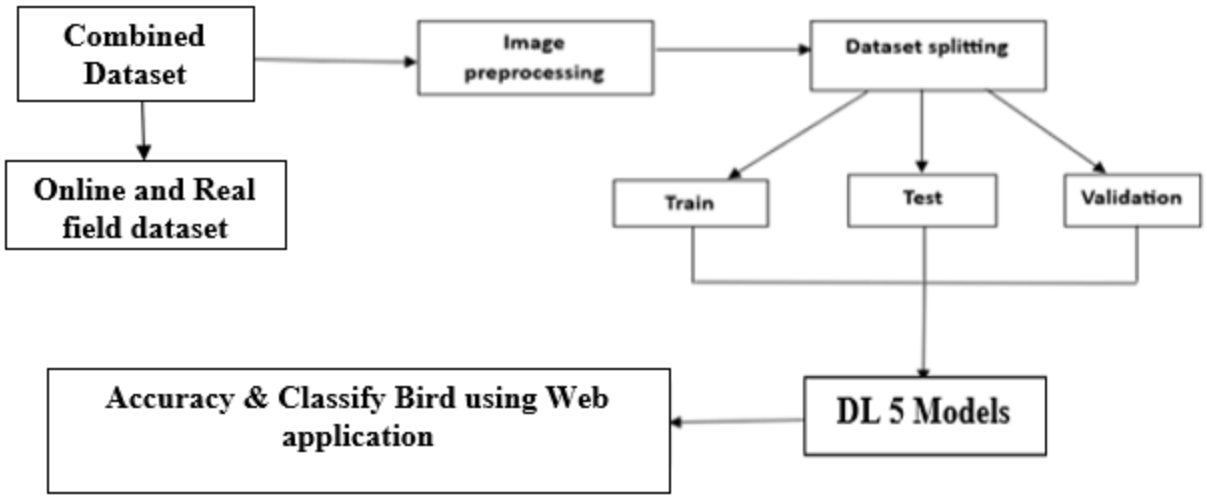


Fig 3.1: Workflow of entire research.

Figure 3.1 illustrates the categorization of bird species using the basic model. It is necessary to initially gather raw data from web sources and bird picture categories in order to create a dataset. After that, the picture was tagged, scaled, and categorized. After then, the machine could get this information. Using fresh, real-time, and integrated internet datasets, I may use this information to train, test, and validate my proposed deep learning approaches. Using photos of various bird species, bird species may be classified with the highest precision possible using deep learning models, owing to the web application's accuracy and the algorithm's accuracy.

3.4 Procedure for Gathering Data

We've put up a collection of 2,552 pictures. To build the final dataset, I blended internet data with real datasets that I got from various fields to take pictures of birds. The dataset is organized into 11 classes: Black Drango, Common Myna, Common Tailor Bird, Crow, Dove, Greater Coucal, Pigeon, Sparrow, Kingfisher, Magpie, and Heron, based on the kind of bird species. Divided the data into two groups: train (80%) and remainder (20%). Divide the remaining data into test (50%) and validation (50%) after that.

Magpie

Greater_Coucal

Dove

Kingfisher

Pigeon

Heron

Fig 3.2: Sample Data of different Bird species.

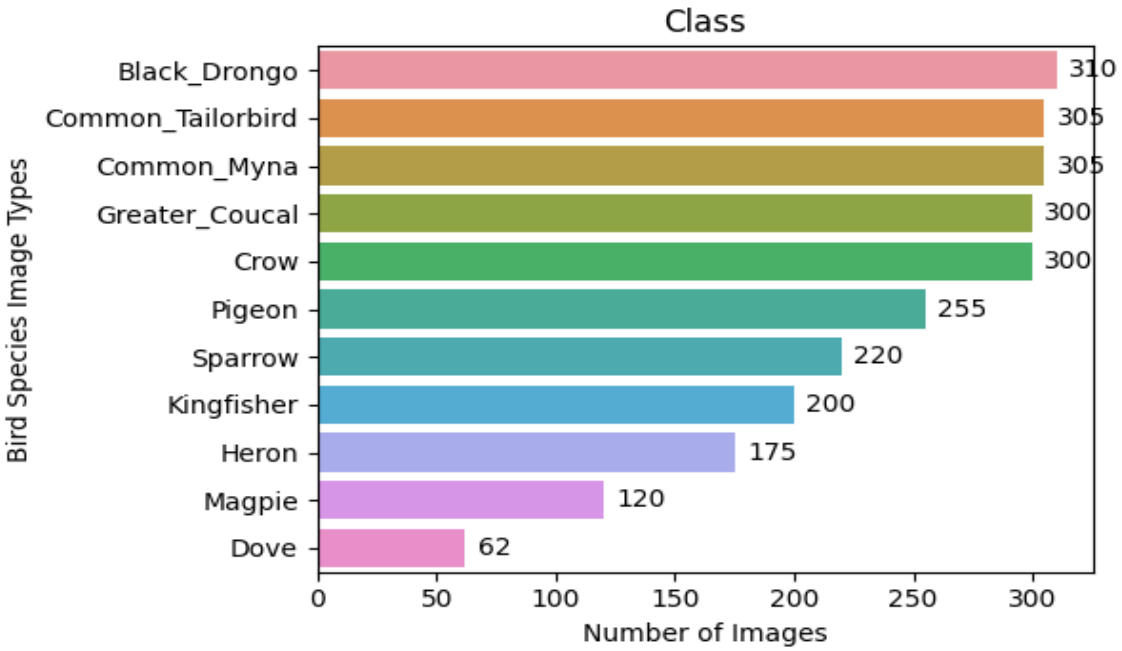


Fig 3.3: Data contains of each class.

Table 3.1: Dataset Table

Classes of Data	**Quantity**
All Image	2,552
Black Drongo	310
Common Tailorbird	305
Common myna	305
Greater Coucal	300
Crow	300
Pigeon	255
Sparrow	220
Kingfisher	200
Heron	175
Magpie	120
Dove	61

Create Labels:

Deep learning methods are often used to datasets with a lot of tags spread over numerous rows or in just one column. Words or numerals can be used as these identifiers. Words are commonly employed to identify the subject being studied in an effort to make it easier for individuals to read. The process of transforming tags into a computer-readable alphanumeric representation is known as encoding. Coding the labels is one phase in this process. DL algorithms may ultimately decide if it's appropriate to use these labels. For uncontrolled training, the dataset stage of planning must be implemented.

3.5 Statistical Analytics

3.5.1 Manipulation of Data

The primary component of data is manipulating it. It is important to consider the data processing method used during a data collection. In particular, refined data is useful when working with actual data. In order to gather information for my study on bird species, I'll be traveling into the field to take pictures of birds and combining them with internet data. The information was then combined with data collected from real birds taking pictures and data from the internet to create a large dataset consisting of 11 categories. The effectiveness of a dataset change is often determined by the data processing done initially. Results generated with greater expertise will be more accurate. An information handling system has two phases: data replenishment and data collecting. In other words, it is the main barrier to this type of research-based job.

I. Data preparation and accumulate: Each image in the collection of photographs I utilized was created by combining web data with raw field data gathered from many locations to capture bird photos, as well as creating a final dataset that fluctuated in width and height. My model requires a specific quality for every image; therefore, I used an altered script to compress the image to a constant 224 × 224 pixels. In addition, I have added the suffix "jpg" to every image in my model before processing it. I edited the photos

after data augmentation in addition to segmenting them and getting them ready for categorization. I used the split version of all the datasets to train the framework because of this.

- Images with fixed sizes based on codes.
- File types being converted to “jpg”.
- Take out any inaccurate images.
- Removed superfluous images.

```
print("The classes:\n", np.unique(df['label']))
```

```
The classes:
 ['Black_Drongo' 'Common_Myna' 'Common_Tailorbird' 'Crow' 'Dove'
 'Greater_Coucal' 'Heron' 'Kingfisher' 'Magpie' 'Pigeon' 'Sparrow']
```

Fig 3.4: All 11 bird species classes.

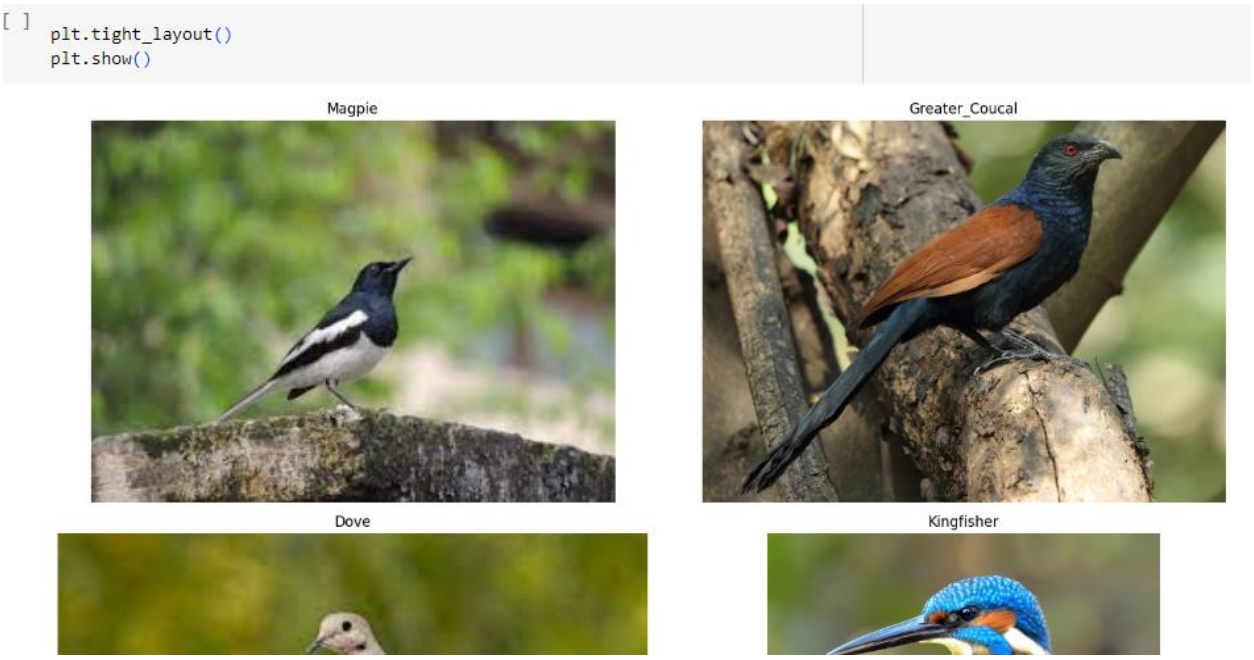


Fig 3.5: Bird and Species label classes: All 11 classes.

3.5.2 Data for Training, Testing and Validation

One of the most well-liked deep learning pastimes is researching and developing techniques that can extract data from record and then project conclusions based on that knowledge. To achieve their objectives, these algorithms employ the input data to create a formula, which they then utilize to interpret or draw conclusions from the data. Before being used in the model-building process, these inputs are frequently divided into many data sets. Three separate data sets are frequently employed while building a model: train, genuine, and test. Divide the original dataset used for training in half: 20% and 80% should go toward training, and 50% and 50% should go toward testing and validation.

3.5.3 Model of classifying

1. **DenseNet169:** The densenet-169 model is used by most of the models included in the Density Net group that were developed for photo categorization. The main differences between the dense net-121 model are its density and accuracy. The densenet-169 model is larger, at around 55MB, than the densenet-121 model, which is around 31MB in size. The authors switched the format of instruction from Torch to Caffe*. Pre-training has been performed on all Dense Base models using the ImageNet image database. The DenseNet169 architecture consists of many layer types, including maxpool, dense, transitional, and convolutional layers. Relu and SoftMax are also used in the design as functions for activation. DenseNet-169 Setup Details As shown, the CNN architecture is composed of three layers: the convolution layer, the combination layer, and the fully linked layer. The convolution layer, the main layer within the Dense Net model, is where the name CNN, Convolutional Neural Network, or simply CNN comes from.

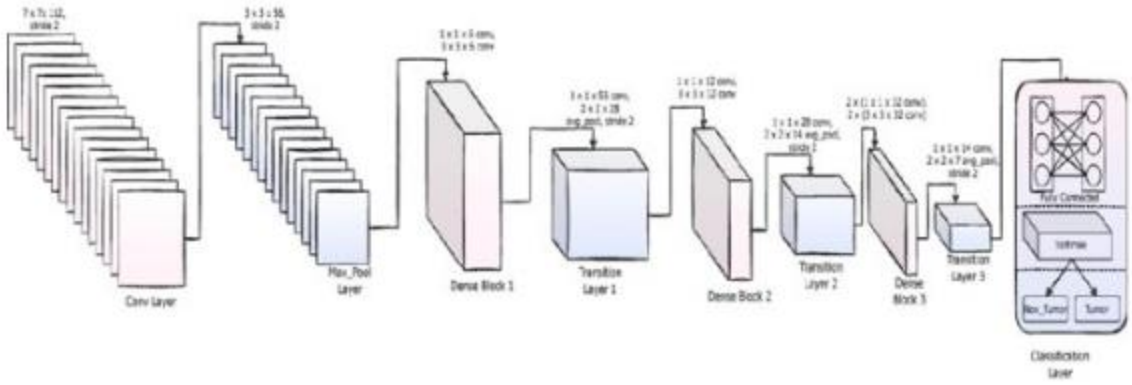


Fig 3.6: Dense Net 169 model architecture.

2. **InceptionV3:** CNN InceptionV3's architecture is used for picture categorization and recognition. It is a part of the collection of Inception DL concepts that the company's employees developed in order to advance. Well-known for its complex construction and creative application of this "Starting section," an exclusive element that improves the system's overall efficiency and accuracy, is the InceptionV3. There are 48 layers in the InceptionV3 is deep neural network architecture. Levels with optimum pooling, fully connected layers, extra classifiers, and convolutional layers are all merged. Because of the monthly mixing and layering randomization of the Creativity module, networks are able to collect data at multiple degrees of abstraction (1x1, 3the quantities of x3, which constitute as well as 5x5).

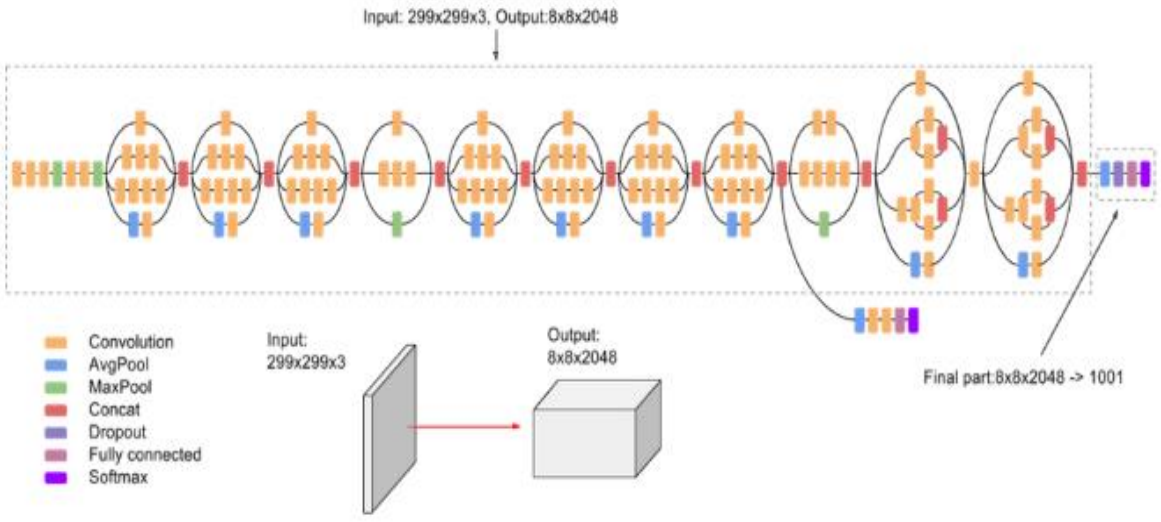


Fig 3.7: Inception V3 model Full version.

3. **MobileNetV2:** MobileNetV2, a neural network architecture, was developed for resource-constrained portable and device edges. Google researchers developed it to offer a small and powerful model for applications involving computer vision such as object detection and image categorization. MobileNetV2, an improvement over the original Mobile Net, includes new features to boost efficiency. MobileNetV2 makes extensive use of depth-wise distinguishable convolutions, which which are made up of a convolution that is depth-wise distinct and a 1x1 pointwise convolution. This separation has a significantly reduced computational cost without compromising expressive capability as compared to ordinary convolutions. The whole architecture of MobileNetV2 consists of the first complete layer of recombination with thirty-two filters. Nineteen lingering bottleneck levels come after it. At the end of the network, global mean pooling is typically employed instead of fully connected layers. There are hence fewer parameters, which aids in preventing overfitting.

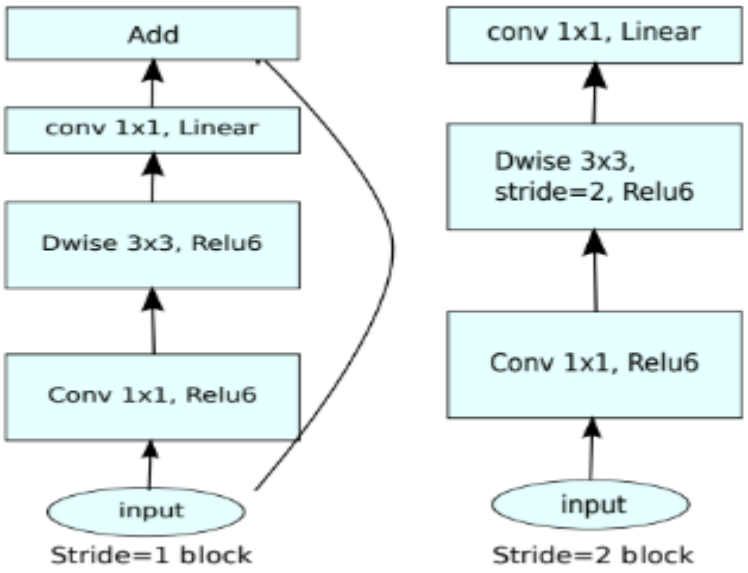


Fig 3.8: Model Architecture of Mobile NetV2.

4. **VGG16:** The VGG model, sometimes referred to as VGG Net, is denoted by VGG16. The framework is an artificial neural network composed of sixteen-layer convolutions (CNN). The ImageNet database contains a pretrained neural network that was developed and

trained on over a million photos. Images of 1000 different item categories, including a computer mouse, keyboard, pencil, and different animals, may be classified by the pretrained network. As a result, a large range of visually rich feature representations have been trained by the network. The network could manage a 224 × 224 picture input size. See Initially learned Recurrent neural networks and models in MATLAB for other preconditioned network options.

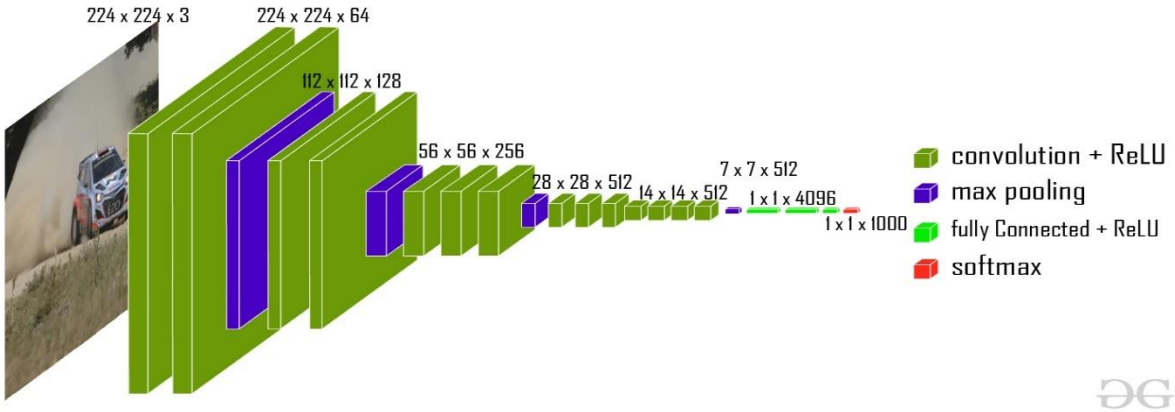


Fig 3.9: Model Architecture of VGG16.

A image is delivered to the network with the dimensions (224, 224, 3). Sixty-four channels with a 3*3 filter region and the exact same padding are included in the first two levels. An additional stage with convolution layers made up of 128 filter measurement with filter size (3, 3) comes after the max pool layer of duration (2, 2). The greatest combining layer with the frequency (2, 2), which is identical to the layer preceding it, comes after this. 256 filters are placed after two convolutional layers with filtered values of three and three. A maximum pool layer sits after two distinct sets of three convolutional layers. Each person has 512 filters with the same padding and a size of (3, 3).

5. VGG19: A variation based on the VGG model with 19 layers of convolutional neural networks, 3 layers that are fully connected, 5 maximal pooling the layers, and 1 The SoftMax algorithm layer is called the VGG19 model. Given that this network was given an RGB picture with a predetermined dimension of (224 * 224), the matrix's structure was (224,224,3). The median RGB value for each pixel—calculated across the entirety of the

training set—was removed as the single preprocessing step. They were able to squeeze in the entire image by using kernels that had a dimension of (3 * 3) and an offset of one pixel. To maintain the depth depth of the image, spatial padding was used. To get the most pooling, speed 2 over 2 * Two.-megapixel frames was employed. Subsequently, a redesigned uniform unit (ReLu) was introduced to improve model classification, accelerate computing, and enhance non-linearity. Previous models relied on sigmoid or tanh functions, but the ReLu turned out to be noticeably better. There were two 4096-sized layers created, and two of them were fully linked. The softer max function serves as the last layer, and there is an additional layer with a channel number of 1000 for a Thousand-way categorizing added to it.

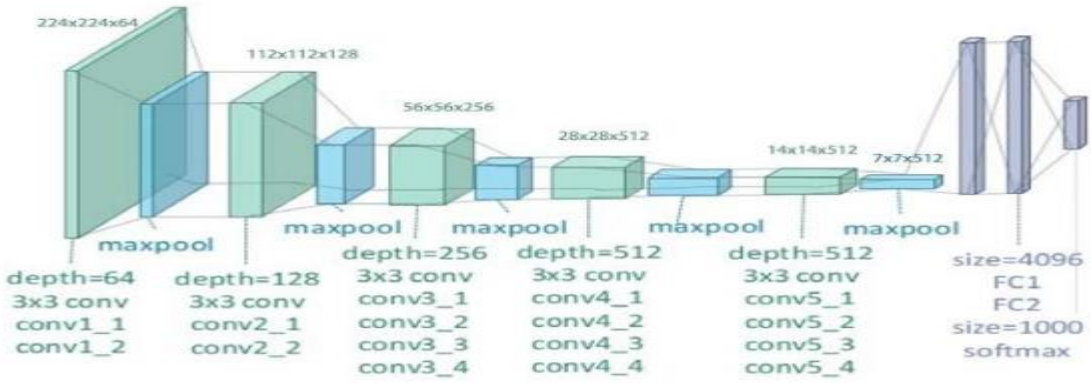


Fig 3.10: Model architecture of VGG19.

3.6 Implementation

To ensure accuracy, the data set must be applied after all ensuing tasks are finished. To make it easier to complete, I divided the work into the six most important sections. To ensure that my work is done correctly, I must adhere to these directions.

- Consolidated collections of real and online datasets.
- Actions taken before processing an image
- Class image prediction.
- The algorithms that are being used.

- Different bird’s species classification with MobileNetV2
- Review the outcomes and correctness.

I have to travel to a field with a variety of species in order to collect bird photographs of those species using my phone's camera and to merge internet data with other data to get precise information from a respectable dataset. After that, I started working on the data processing. Here, I removed any unnecessary components from my data, like noise, erroneous photos, improperly scaled photographs, etc. For the lengthier data train, test, and validity periods, I also employ data generators.

I started playing around with the code as a preliminary to actually implementing the idea. I evaluated the accuracy of each of the 5 used algorithms. Once the process was complete, I assessed its correctness. I evaluated the accuracy and decided whichever would be most helpful for my purposes. While it concerns species that use data from birds, this has demonstrated to be reasonably trustworthy. A comprehensive analysis of all relevant mathematical and philosophical ideas and techniques has resulted in the formulation of an assortment of prerequisites that are required for any attempt at picture classification. The following results could be required:

1. Hardware and Software Requirements

- Operating Systems: Windows 7 or later;
- Hard Drive: 1 TB or more;
- RAM: 4 GB or less

2. Tool Development

- Environment of python
- PyCharm.
- Google Colab.

CHAPTER 4

Experiment Results and Discussion

4.1 Introduction

This section explains the whole species of bird's category using an image classification approach for birds. Obtaining the photos, evaluating the data, preparation data, adjusting the quantity of information, putting forward models, and offering guidance in accordance with the model's accuracy were all steps in the process of creating the model. This chapter presents and discusses the investigation's results.

4.2 Experimental Result

Numerous algorithms have forecasted the identification of many bird species. As a result, I employed several different techniques. Before selecting the optimal course of action for the experiment, I considered and assessed a number of choices. I experimented with several methods to raise the standard of my work. employed unprocessed field datasets to take pictures of birds, which were then matched with photos found online to create data for 11 classifications. All of the photo sets include pictures of different bird species that may be identified via an online application.

I made use of Python libraries, content classification strategies, and pre-existing dictionaries. The deep learning technique looks at eleven different bird species, including Black Drango, Common Myna, Common Tailor Bird, Crow, Dove, Greater Coucal, Pigeon, Sparrow, Kingfisher, Magpie, and Heron, which makes the dataset relevant. Once more, deep learning is employed in this study to identify the appropriate bird species from images of birds by utilizing Python DL algorithms for categorization. creating a web application that uses images of birds to determine if everything belongs to a particular class of bird.

4.3 Applying Descriptive Analysis with DL models and Web prototype

Depending on the categorization methods I used, I got different results. Using photographs of different bird species, I applied five different DL algorithms to determine the precise location of the birds. I employed deep learning approaches such as DenseNet169, MobileNetV2, InceptionV3, VGG16, and VGG19, which have demonstrated promising outcomes in terms of bird species

accuracy while employing 10 epochs. Every model made use of the same dataset, which comprised both publicly accessible data and my own dataset, which I gathered directly from different locations to obtain photographs of birds and internet data shortly after deciding that the data set was the best choice. Using Mat-lab and its pre-made libraries, I assessed the algorithms' correctness after finishing the dataset operation. I also used web prototypes to predict the species of birds.

Table 4.1: Accuracy table

Models	**Accuracy Score (AUC)**
DenseNet169	92.97%
MobileNetV2	94.92%
InceptionV3	90.23%
VGG16	85.55%
VGG19	84.38%

A number of models' efficacy is shown in the section that follows. Two open-source tools that were used in the process were PyCharm and CoLab. In all, five models were used: MobileNetV2, InceptionV3, VGG16, VGG19, and DenseNet169. With an accuracy of 94.92%, the MobileNetV2 models performed the best.

	precision	recall	f1-score	support
Black_Drongo	0.92	1.00	0.96	36
Common_Myna	1.00	0.94	0.97	35
Common_Tailorbird	1.00	0.93	0.96	27
Crow	0.93	0.93	0.93	29
Dove	0.75	0.60	0.67	5
Greater_Coucal	1.00	1.00	1.00	29
Heron	0.94	1.00	0.97	16
Kingfisher	1.00	1.00	1.00	18
Magpie	1.00	0.89	0.94	9
Pigeon	0.94	0.88	0.91	33
Sparrow	0.83	1.00	0.90	19
accuracy			0.95	256
macro avg	0.94	0.92	0.93	256
weighted avg	0.95	0.95	0.95	256

Fig 4.1: MobileNetV2's Classification Report.

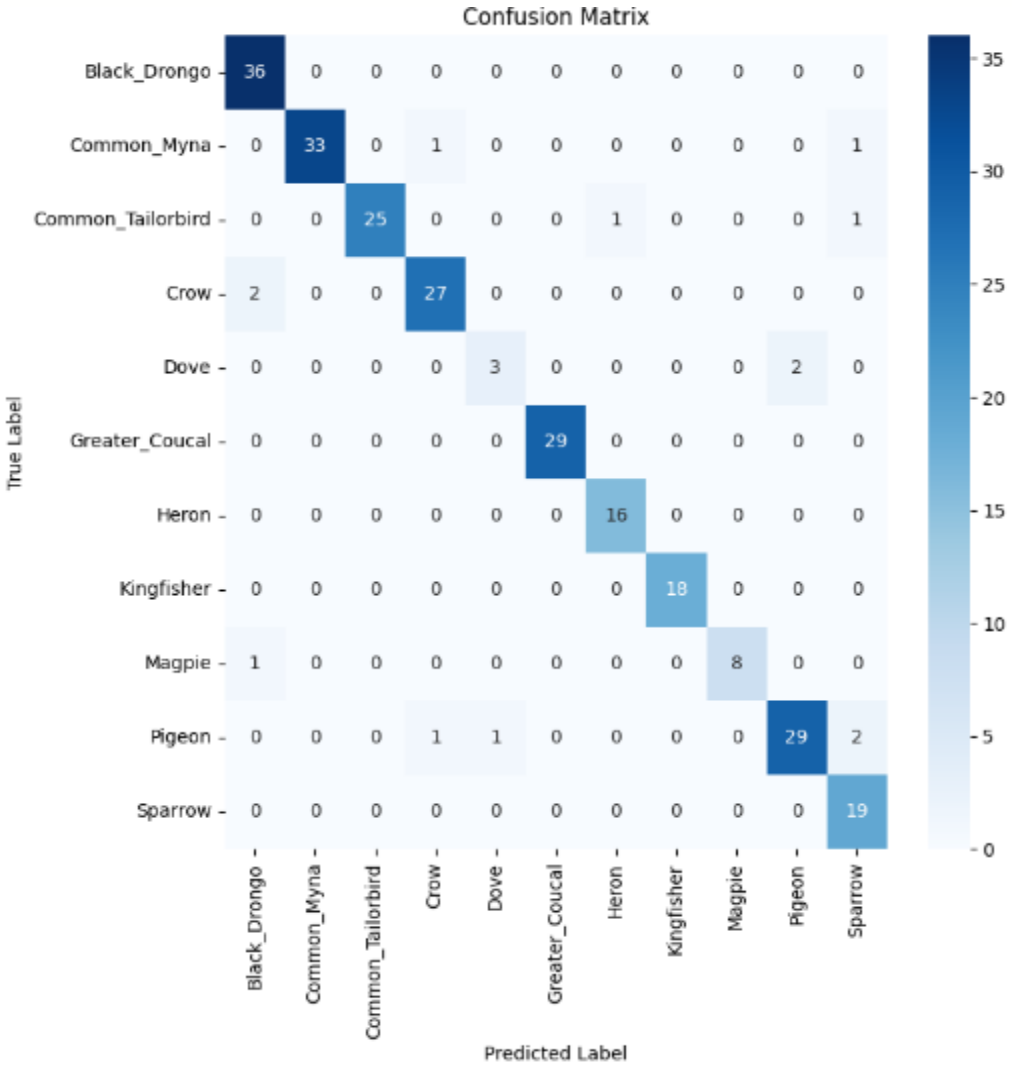


Fig 4.2: MobileNetV2's confusion matrix.

It is only showing the full classifying reports for the MobileNetV2 algorithms in order to get the highest accuracy.

The procedure for categorizing a particular species of bird and creating a workable web application using the CNN technique MobileNetV2 model is shown in Fig. 4.3 below. Figures 4.4, 4.5, 4.6 and 4.7 show the 11 distinct kinds of The birds images—Black Drango, Common Myna, Common Tailor Bird, Crow, Dove, Greater Coucal, Pigeon, Sparrow, Kingfisher, Magpie, and Heron—that could be predicted with accuracy using an internet algorithm that employed MobileNetV2. As is

typically the case, deep learning is among the least supervised techniques for object detection or prediction.

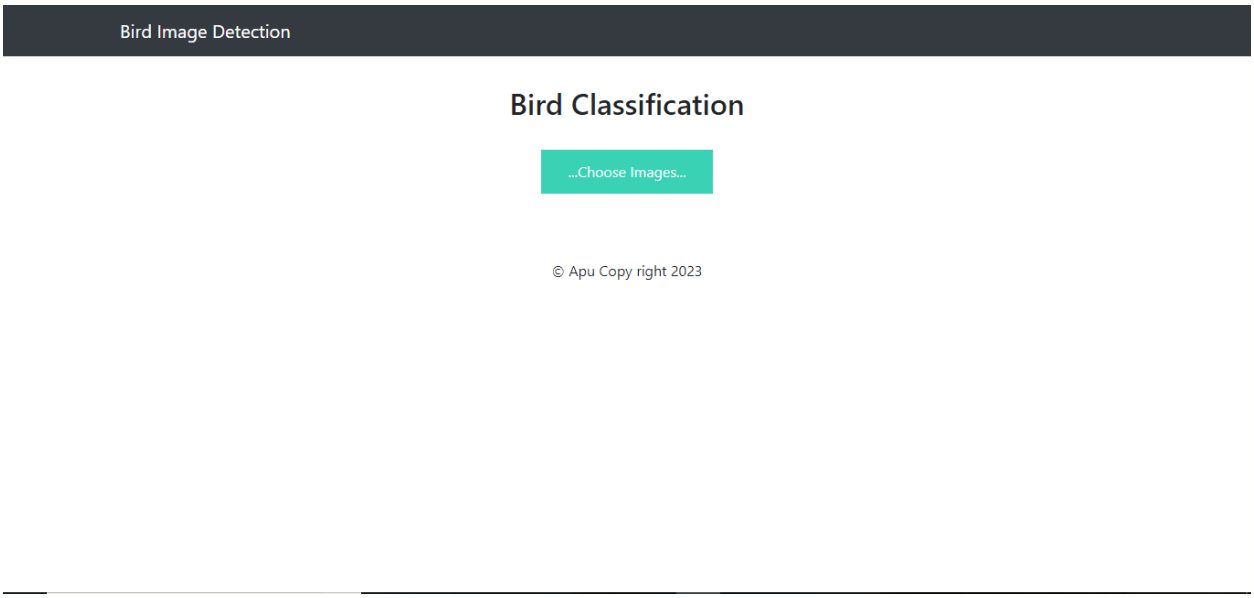


Fig 4.3: Prototype web application for classifying Birds Species

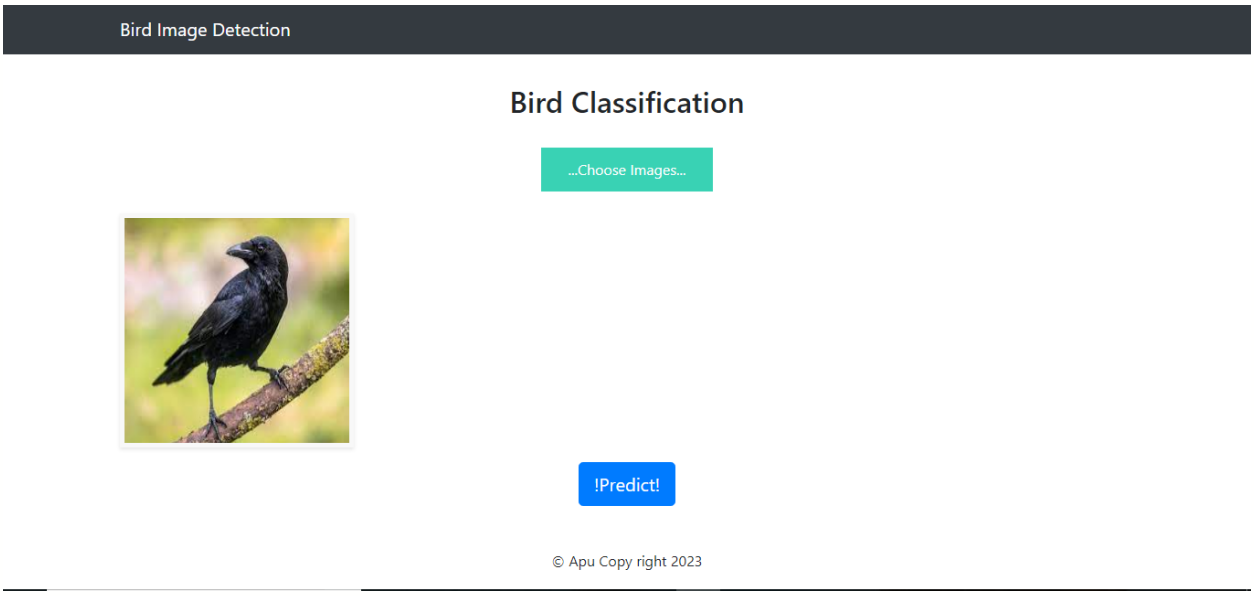


Fig 4.4: A prototype of a web application to choose images

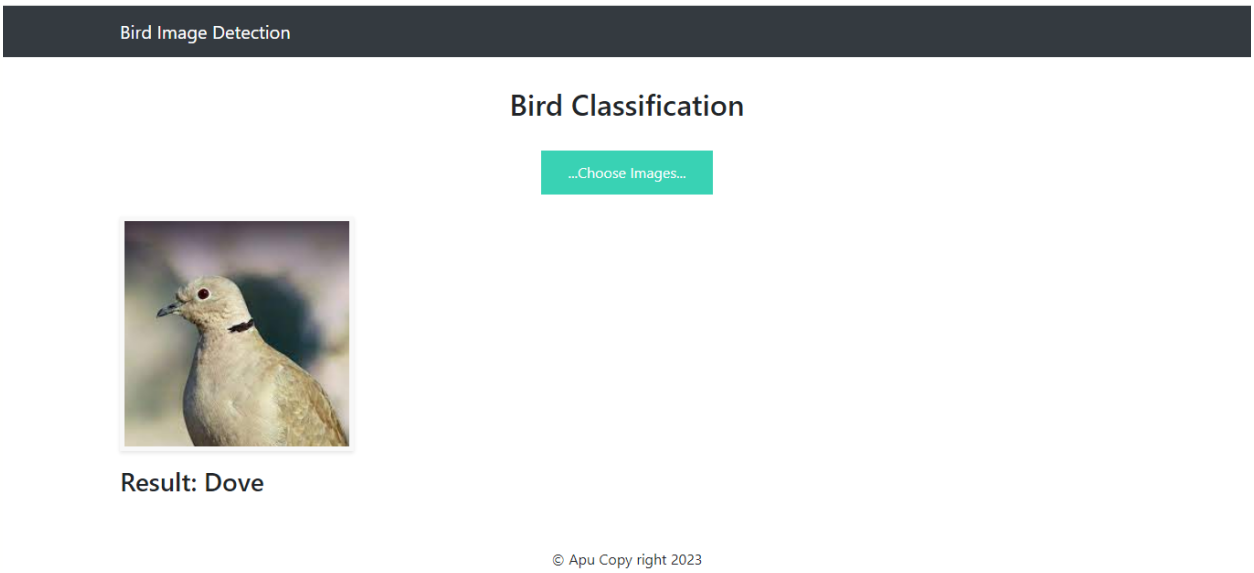


Fig 4.5: "Dove" species classification of a web application prototype

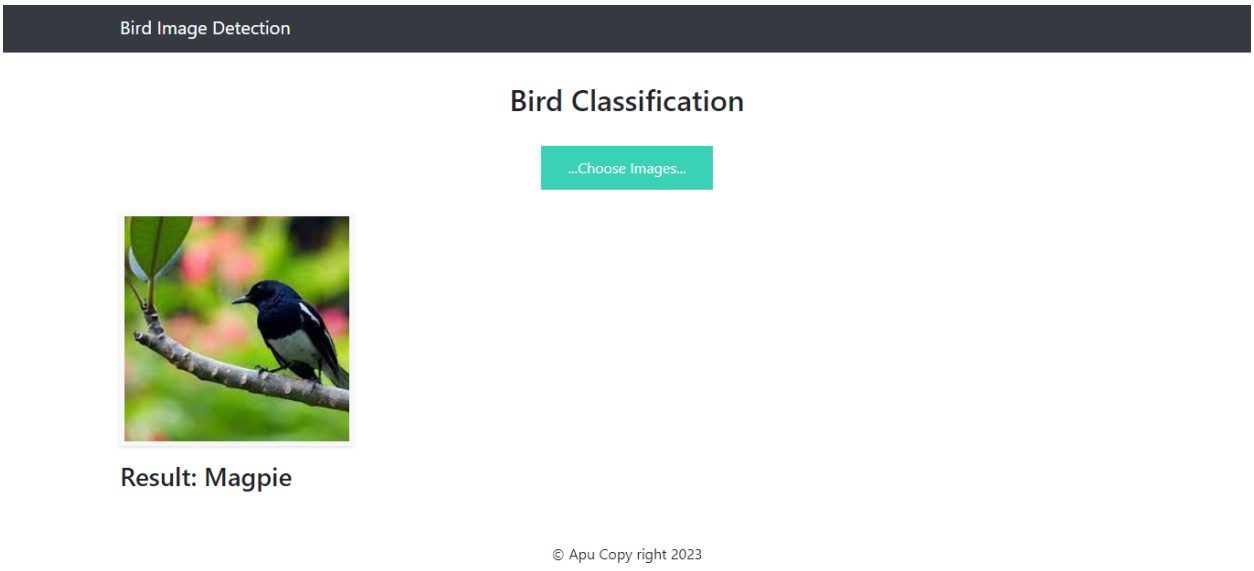


Fig 4.6: "Magpie" species classification of a web application prototype

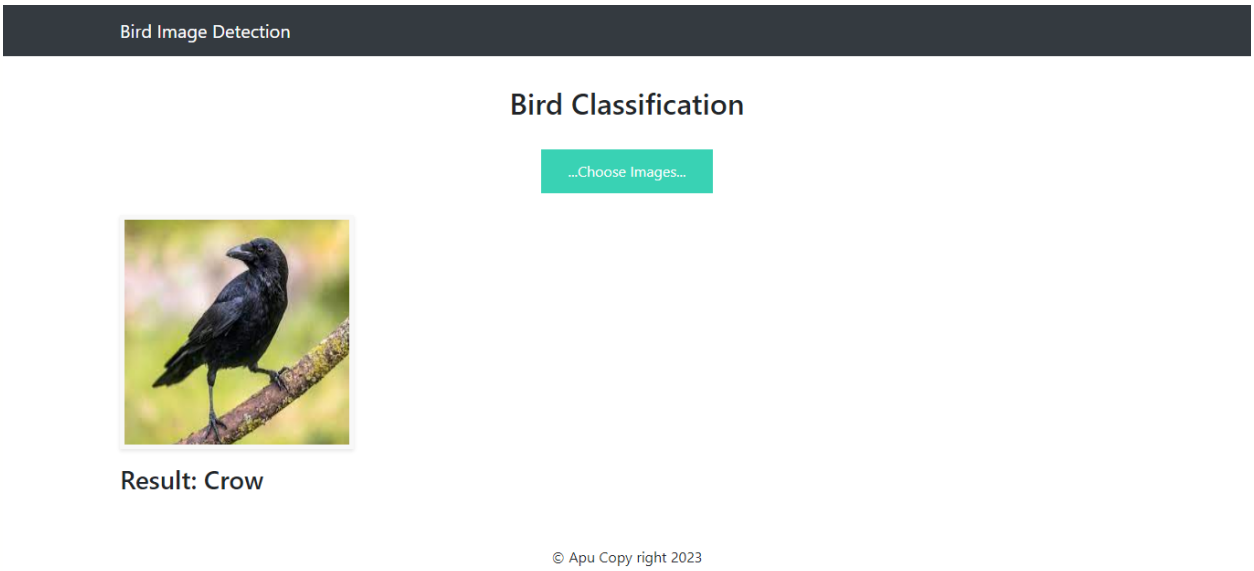


Fig 4.7: "Crow" species classification of a web application prototype

Figures 4.8 and 4.9 below show the MobileNetV2 models' train and validation accuracy as well as loss at an epoch of 10.

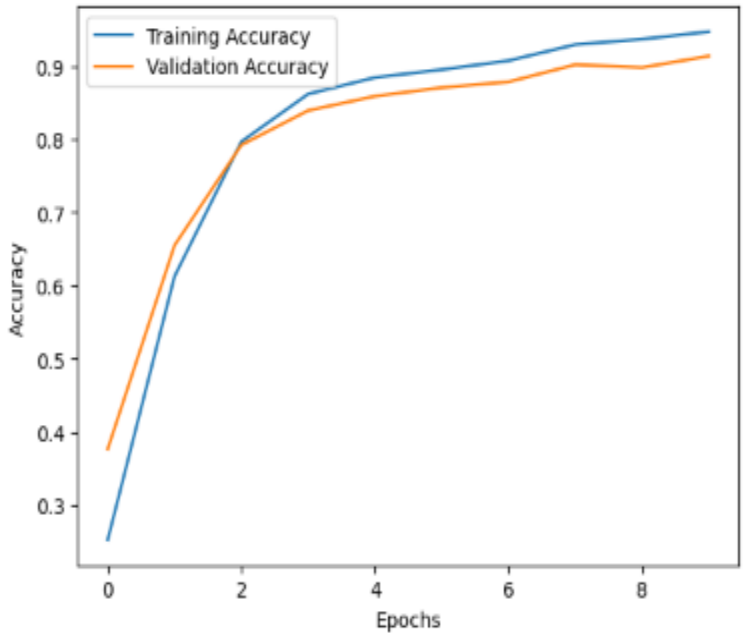


Fig 4.8: MobileNetV2 Accuracy Curve for Training and Validation.

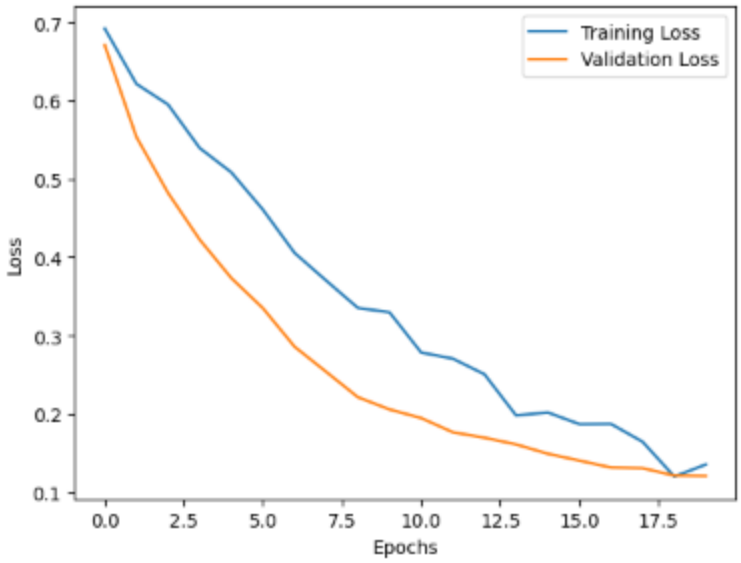


Fig 4.9: MobileNetV2 Loss Curve for Training and Validation

4.4 Discussion

In this project, I'll use DL algorithms and bird pictures to predict the species of birds. Every word should be given a substantial amount of weight during the classification process in any field of study. I have always researched species classification to find out why birds exist. The dl models have also been used to separate the datasets into subsequent classes. The data is one of the most important parts of any investigation. The data presented may cause a major change in the study's results. Because this was a combination of real datasets, I was confident that researchers who were using one of the two previously available datasets would come to different conclusions. I may be seen as a little more reliable because I used more data.

To assist us in reaching my goal, I employed a variety of DL method techniques and accuracy ratings. I used a total of five different algorithms for this project. Prior to starting my current project, I needed to gather a few things. Yes, I made my decision and got to work on the algorithm. Next, I determined each algorithm's accuracy. like I've already said.

I used both of these tactics to get the maximum accuracy of 94.92% for the MobileNetV2 modeling, these are the predictions for the next two categories. It is especially noteworthy for the

data I supplied since, when it came to the eleven bird species identification classes utilizing photographs of birds from the online application, it performed more accurately than the other models.

Precision: One measure that is frequently used to evaluate the model's effectiveness is accuracy, or the degree of precision of the correct forecasts the algorithm produces. The entire number of accurate forecasts may be multiplied by the entire amount of actual positives to determine efficiency.

$$\text{precision} = \frac{TP}{TP+FP}$$

Recall: Retrieval is the percentage of appropriate cases that were ultimately found and recovered, regardless of all relevant examples. A method is thought to have yielded the most relevant results when its recall rate is high.

$$\text{recall} = \frac{TP}{TP+FN}$$

F1-Score: The validity of a test is established by taking into account its accuracy and recall. Recall and accuracy complement each other well.

$$\text{F1} = \frac{2 \times precision \times recall}{precision + recall}$$

Accuracy: Reliability is the link between a confessed cost and a projected benefit.

$$\text{accuracy} = \frac{TP+TN}{TP + FN + TN + FP}$$

CHAPTER 5

Impact on Society, Environment and Sustainability

5.1 Impact on Society

These days, Bird activity and population trends have become a major problem. Because they adapt quickly to environmental changes, birds help us identify various animals in the climate (such as the creepy crawlies they consume). But maybe the primary reason to focus on birds is to increase our understanding of the biological mechanisms supporting all life on Earth, including human life. Numerous parts of the planet's ecosystems would collapse in the absence of pure air, water, and soil as well as vibrant, interconnected regular cycles.

5.2 Impact on Environment

In many regions of the nation, ecotourism connected to bird watching and associated activities dominate the economy. In tiny quantities, birds are the only animals that bring happiness, delight, and spiritual inspiration to people. Another great indication of the health of the ecosystem is birds. Prior to the expression "the canaries in coals mines" becoming overused, underground laborers really used canaries to help with early gas and carbon monoxide detection. Because of their high food chain position, simple observation, quick metabolism, and relative abundance, birds in the natural world can give insights on other hard-to-detect processes. The decline in Bald Eagle and Peregrine Falcon populations provide crucial information regarding the hazards and dispersal of metals such as lead and DDT. These days, variations in bird populations may reveal a great deal about the effects of global warming, drought, and weather patterns both domestically and abroad.

Regardless, maybe the primary reason to focus on birdlife is to increase our understanding of the ecosystems that support all life on Earth, including human existence. In order to maintain a sustainable way of life and a stable world, we need to understand how the regular systems that support us function. Birds are an essential part of almost every ecosystem on Earth, and our future is entwined with theirs. These days, observing birds is a common pastime; nevertheless, bird books are necessary to identify their species. In order to provide birdwatchers with a useful tool for appreciating the beauty of birds, we developed a deep learning stage to assist clients in identifying

different bird species using programming based on the concept of picture recognition. By comparing the model with a prepared model, this product would be able to interpret the information image and predict the species of birds. That way, the nuances would come out. Furthermore, it will help us construct the dataset in the event that any image captured or sent by the client is not included in the dataset; in that case, the client can contribute the image.

5.3 Ethical Aspects

The primary goal of creating this identification site is to raise public knowledge of birding, identification, and bird watching, particularly with regard to the birds of Bangladesh. It also meets the requirement to streamline the process of identifying birds, which facilitates bird viewing. Convolutional neural networks are the method utilized in the experimental setting (CNN). For picture recognition, feature extraction is used. The technique employed is adequate for feature extraction and picture classification.

5.4 Sustainability Plan

For a deep learning bird categorization project, a sustainability strategy must take into account a number of factors, including the project's long-term viability, environmental effect, and ethical issues. Make that the model was trained with ethically generated and labeled data. Steer clear of data that could have been gathered unethically or that could endanger animals. While deploying and training hardware, choose for energy-efficient models. Think about utilizing cloud services that prioritize sustainability, such those that run on renewable energy. Create educational resources to tell people about how AI models affect the environment. Encourage conscientious use and raise consciousness concerning the project's eco-friendly initiatives. You may lessen the impact on the environment and encourage the appropriate use of AI by taking these factors into account and incorporating environmentally friendly techniques into the design and implementation of your bird categorization project.

CHAPTER 6

Conclusion and Future Research

6.1 Summary of the Study

This inquiry has taught me a lot regarding this topic. A species of bird is a delicate matter. This is a significant yearly factor in the bird's sector's downturn. As a result, utilizing the dataset's bird photos, I was able to use deep learning to recognize 11 common species of birds.

As I've already shown, I use a range of locations to obtain as many actual facts as possible for my studies on birds. I was able to get better at identifying particular bird species by using this data to train my software algorithms on the birds species pattern. At first, a few problems were fixed. I was able to accomplish my desired goal. For various users, different DL algorithms produce different outcomes. In the next part, I go into further detail on this.

6.2 Conclusion

This study demonstrates how good my methods and findings were. I really think and anticipate that more research in this area will be started when my evaluation is over. I have a ton of ideas to expand on my work thanks to this study. While at work, I made a few blunders. I learned that there were many educational paths I might have taken. We will be able to address any shortcomings or possible problems while carrying out the present project. Furthermore, I offer recommendations for the use of these insights in future research to offer more thorough resolutions to the problems brought up by this investigation. I'm sure that this test will help me understand more about the different aspects of the bird topic I've selected to study. It will, in my opinion, contribute to the advancement of cutting-edge technological approaches and research that will allow us to service the bird business and use bird photos for the diagnosis of different species. By using DL to ascertain whether or not these eleven sets of bird species—Black Drango, Common Myna, Common Tailor Bird, Crow, Dove, Greater Coucal, Pigeon, Sparrow, Kingfisher, Magpie, and Heron—are related, I want to present a novel method for classifying bird species based on bird photos. developing a website application for the categorization of bird species photos as well.

6.3 Possible impacts

The identification of birds in species photos may be done with greater accuracy thanks to deep learning algorithms. With the use of enormous datasets, they may be trained to recognize intricate patterns or tiny birds that would be difficult for actual radiologists to spot. The use of deep learning for species of bird's detection may make bird categorization services more accessible, particularly in underdeveloped or isolated locations where access to qualified medical personnel may be limited.

6.4 Implications of Further Study

Further research in this area might take numerous forms, especially within the scope of my own study. I had a lot of ideas on how to make my work better. As I mentioned before, I have also found a few errors, and these mistakes present chances to make this research better. I'll try to address this inaccuracy by putting my ideas into practice and improving prediction results with more chances to capture high accuracy. I plan to fix any errors that come up.

I'm preparing for more goals. This prediction—which uses photos of birds to identify different species—may call for more study in this area. I will include components like bird species kinds of categorization using MobileNetV2 mimic and other aspects into the method that I use to build the birds categorization that users may use to decide 11 classes of birds in order to help the user get the most out of this. With this kind of work, I think I can improve equipment and increase its important impact on bird health. I may help identify the people's birds' species early on.

Reference

[1] K.M. Ragib, R.T. Shithi, S.A. Haq, M. Hasan, K.M. Sakib, and T. Farah, "Pakhichini: Automatic bird species identification using deep learning". In *2020 Fourth world conference on smart trends in systems, security and sustainability (WorldS4)* (pp. 1-6), 2020, July. IEEE.

[2] S. Fagerlund, "Bird species recognition using support vector machines," EURASIP Journal on Applied Signal Processing, vol. 2007, no. 1, pp. 64–64, 2007.

[3] E. Vilches, I. A. Escobar, E. E. Vallejo, and C. E. Taylor, "Data mining applied to acoustic bird species recognition," in 18th International Conference on Pattern Recognition (ICPR'06), vol. 3. IEEE, 2006, pp. 400–403.

[4] E. Sprengel, M. Jaggi, Y. Kilcher, and T. Hofmann, "Audio based bird species identification using deep learning techniques," Tech. Rep., 2016.

[5] M. Graciarena, M. Delplanche, E. Shriberg, and A. Stolcke, "Bird species recognition combining acoustic and sequence modeling," in 2011 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). IEEE, 2011, pp. 341–344.

[6] J. Niemi and J.T. Tanttu, "Deep learning case study for automatic bird identification", *Applied sciences*, *8*(11), p.2089 , 2018.

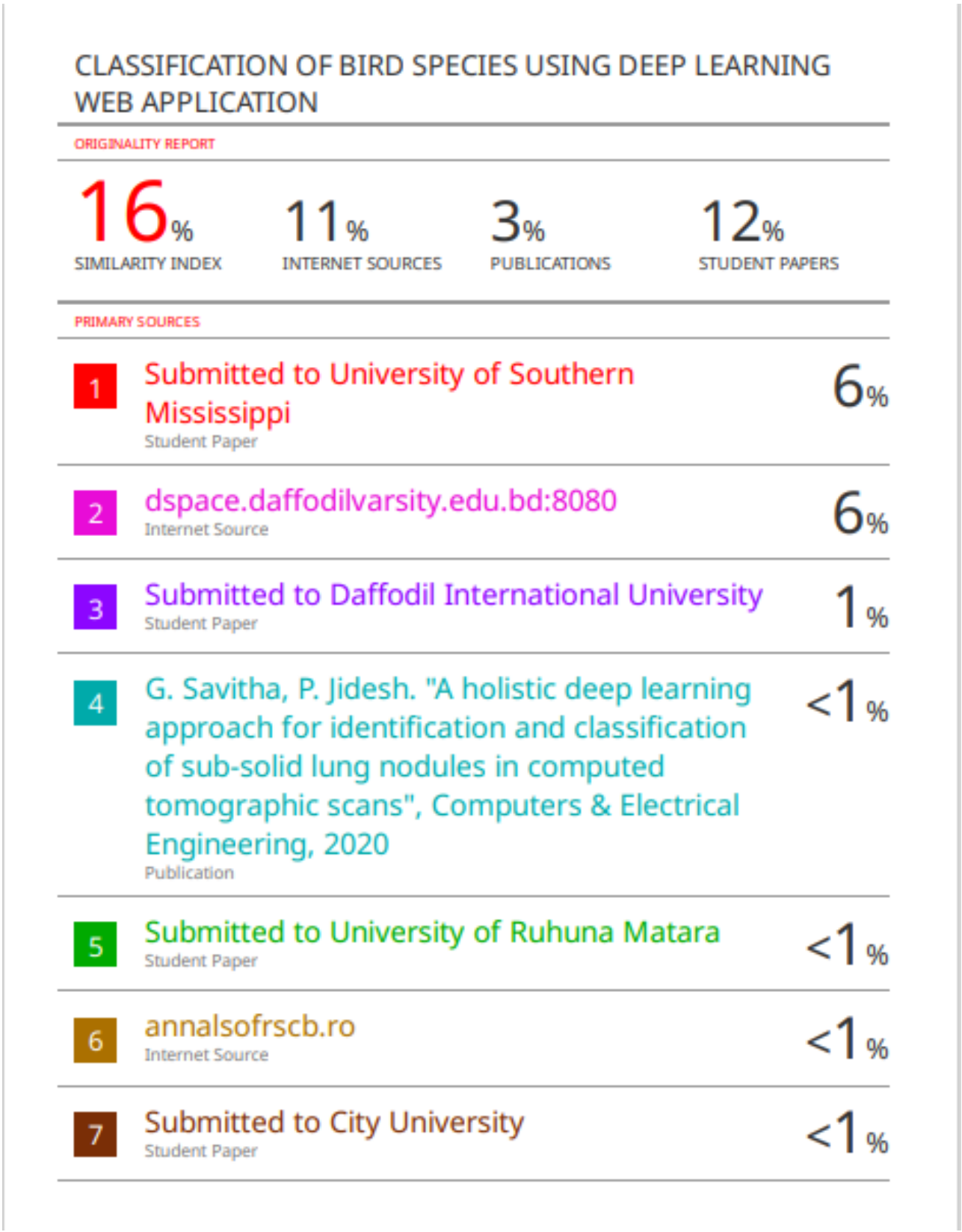
[7] P. Datar, K. Jain and B. Dhedhi, "Detection of birds in the wild using deep learning methods" In *2018 4th International Conference for Convergence in Technology (I2CT)* (pp. 1-4), 2018, October. IEEE.

[8] B. Reyers, E.R. Selig, "Global targets that reveal the social-ecological interdependencies of sustainable development" Nat Ecol Evol 4, 1011–1019 (2020).

[9] F. He and S.P. Hubbell, "Species–area relationships always overestimate extinction rates from habitat loss", *Nature*, *473*(7347), pp.368-371, 2011.

[10] G. Van Horn, S. Branson, R. Farrell, S. Haber, J. Barry, P. Ipeirotis, P. Perona, and S. Belongie, “Building a bird recognition app and large scale dataset with citizen scientists: The fine print in fine-grained dataset collection,” in The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), June 2015.

[11] J. Salamon, J. P. Bello, A. Farnsworth, and S. Kelling, “Fusing shallow and deep learning for bioacoustic bird species classification,” in 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). IEEE, 2017, pp. 141–145.



CLASSIFICATION OF BIRD SPECIES USING DEEP LEARNING WEB APPLICATION

ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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