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DIGITAL NATURALIST USING HYBRID LEARNING MODEL

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Abstract: A naturalist explores different species of flora and wildlife as well as the patterns found in nature. This study intends to develop a web application that aids naturalists' research of numerous species using deep learning and artificial intelligence, hence the term "Digital Naturalist." Convolution Neural Networks (CNNs) are a type of deep learning technique used for processing pixel data and image recognition. Python is another language used by the programme to carry out this categorization. Our programme is special since it makes use of the highly trained neural network "AlexNet." This website app assists in both species research and ecological preservation by saving endangered species. Additionally, the application can handle a load of more than 1000 users at a time.

IndexTerms **– Real-time image processing, Deep learning, Artificial Intelligence.**

I. INTRODUCTION

A naturalist is a person who observes natural patterns and recognizes various flora and wildlife in the wild. Understanding the local flora and wildlife may spark an interest in preserving natural areas, and conservation organizations like NCC can benefit greatly from the knowledge we gather and share on the particular species we see while travelling. Field naturalists frequently rely on conventional strategies when exploring the woods, such as always bringing a guidebook with them or asking knowledgeable ornithologists for assistance. They ought to have access to a useful instrument that allows them to notice, catalogue, and communicate the beauty to others. This online software can only be used by field naturalists to recognize the birds, flowers, animals, and other species from anywhere. They observe when they are on their walks, canoe trips, and other outings. In this project, we're building a web application that employs a deep learning model trained on various bird, flower, animal, and insect species to identify the species when an image is provided. The subject of Digital Naturalism is the potential use of digital media in biological field work. It aims to retain the wilderness exploration's basic principles while exploring the new capabilities provided by digital technology. To create and evaluate new technology, digital naturalism brings together designers, biologists, engineers, and artists. The emphasis is on creating DIY technology and finding novel methods to communicate with animals. Digital Naturalism, in particular, examines how animal behaviors might be explored using digital media in the context of their natural habitat. This study has most recently been conducted in the field through hiking hackathons.

II. LITERATURE SURVEY

Its objectives go beyond simple identification of the flora and wildlife; learning about their behaviours, habitats, ways of life, and groupings results in the retrieval of services for conservation as well.The given photos from the dataset are predicted using segmen tation and CNN utilising a web application [2]. Convolutional Neural Network (CNN) and image processing are used for bird identification from images and transfer learning is used to train our model. For the species identification challenge, which will require a larger amount of data, they are developing their own neural network model; instead, they employ a pre-trained model and carry out transfer learning on our dataset [3]. The input photos are of the same size and have been normalized. In the models shown, convolutional layers provide either 32 or 64 feature maps, which indicate important features in the image that were picked up by the convolutional layer. They created a CNN that can be used to detect fish for research and fishery purposes and be applied to datasets gathered by research organizations like the Nature Conservancy. Automating image processing is possible with the help of machine learning techniques [4]. The samples are divided into segments using Otsu's thresholding method in the suggested methodology, along with any necessary pre-processing. Processed Arecanut is often categorized and graded according to its color, shape, and texture. Different external features like color, shape, and texture were extracted for the classification and grading of arecanuts [5]. Convolutional neural network (CNN) (Tenser Flow) is a deep learning algorithm for classifying images. It performs this bird classification using the Python language. Numerous neurons were found using deep learning models [6]. They suggested a ground-breaking training criterion for deep neural networks for maximum interval minimum classification error based on an analysis of the error back propagation technique. In order to produce better findings, the cross entropy and M3 CE are analyzed concurrently [8].

III. PROPOSED SOLUTION

A naturalist is someone who investigates the patterns seen in nature and recognizes various flora and fauna in its natural settings. Understanding the local flora and fauna can spark an interest in conserving natural areas, and sharing and collecting data about the species we encounter while travelling is particularly helpful for conservation organizations like NCC. This problem can be solved using Artificial Intelligence. Artificial intelligence can be used to identify all the classes and species of animals and plants based on the set of databases. We use deep learning approach to train a long and heavy data that are useful for a naturalist to classify images based on the nature of species. The uniqueness of our application is that we use very deeply trained neural network named AlexNet. It is a powerful CNN model that can classify more than 20000 classes of images. Its weights are predefined so we do not need to train the model which helps us to save computational cost. Based on the data availability, we further include more classes in training the model. It is a useful product for all the research analyst, Ornithologist, Biologist and Marine drivers who can instantly capture images of different species and are able to get all the relevant information about those breeds. We can introduce subscription-based approach to earn a good revenue. The greater number of features attracts the end users to use our application. It can generate up to an income of more than 10 million per year. Our application can handle more than 1000 users and load at a time, without compromising on performance and causing disruptions to user experience.

IV. DESIGN APPORACH

- The project is a form a web application that is created with highly secure authentication.
- Once the user fed the data to the model, the prediction for that image along with basic data of that species.

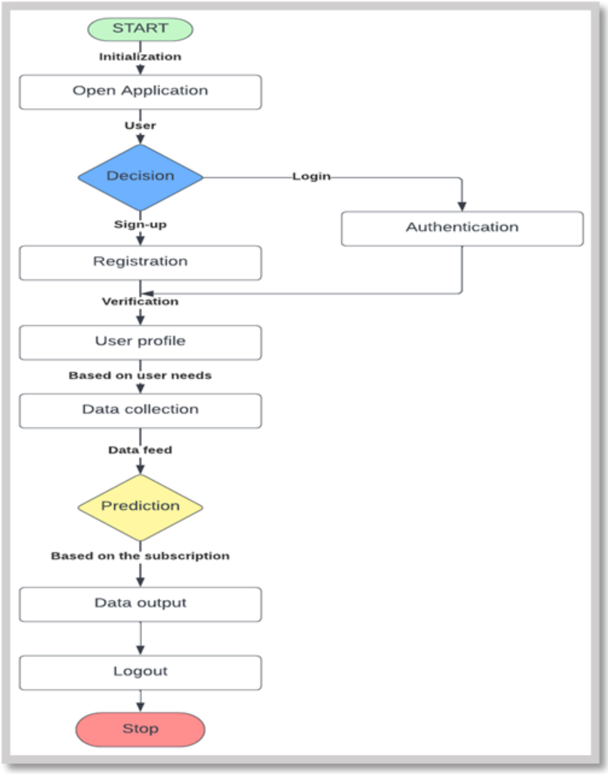

Figure 1. Overall flow diagram of design approach

The below diagram shows the flow of data and fetching of data from database based on the requests and response

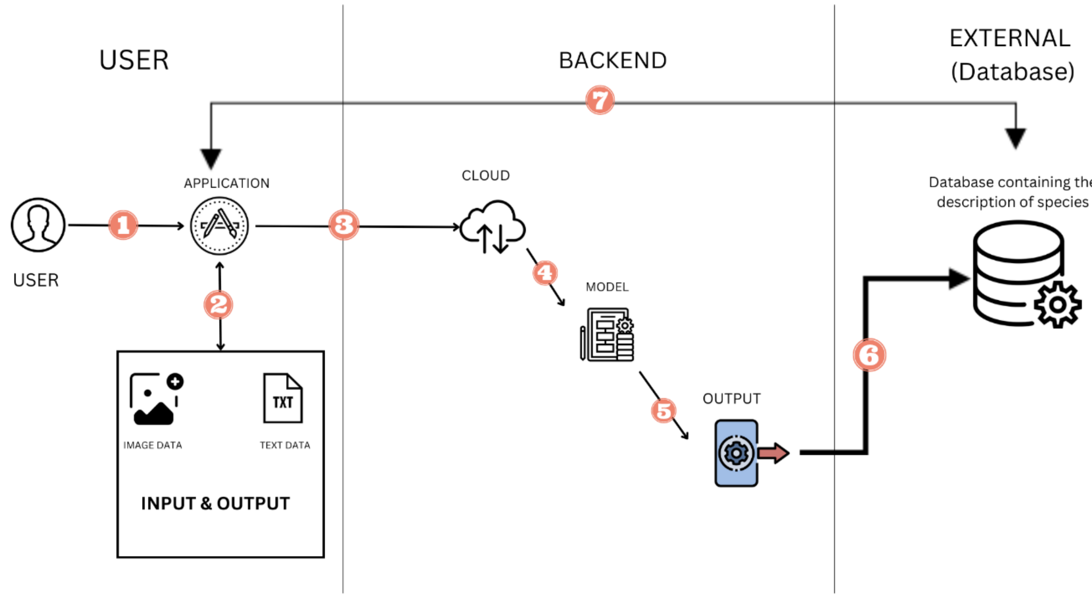

Figure 2. Data Flow Diagram

V. IMPLEMENTATION

AlexNet Architecture:

AlexNet is a deep convolutional neural network trained on more than a million photos from the ImageNet collection. It demonstrated how learning-based features can exceed manually created features, upending the conventional wisdom in computer vision. The AlexNet architecture is composed of eight layers, comprising three completely connected layers & five convolutional layers. ReLU activation functions are used in convolutional layers while sigmoid activations are used in fully connected layers.

AlexNet's first layer is a convolutional layer with 96 filters, each measuring 11x11 pixels, with a stride of 4. A 224x224x3 RGB image serves as the input to this layer, where 224x224 denotes the spatial resolution and 3 the quantity of color channels (red, green, and blue). The layer's output is a tensor with the dimensions 55x55x96, where 55x55 represents the spatial resolution and 96 represents the number of filters.

A max pooling layer with a stride of 2 and a filter size of 3x3 makes up AlexNet's second layer. The input's spatial resolution is decreased by this layer from 55x55 to 27x27.

A convolutional layer with 256 filters of size 5x5 and a stride of 1 makes up AlexNet's third layer. This layer produces a tensor of the dimensions 27x27x256.

Another max pooling layer with a stride of 2 and a filter size of 3x3 makes up AlexNet's fourth layer. The input's spatial resolution is decreased by this layer from 27x27 to 13x13.

A convolutional layer with 384 filters of size 3x3 and a stride of 1 makes up AlexNet's fifth layer. This layer produces a tensor of the dimensions 13x13x384.

AlexNet's sixth, seventh, and eighth levels each have 4096 neurons and are completely connected layers. These layers' input is flattened into a vector with a length of 6,144.

A vector of length 1,000 reflecting the expected probability for each of the 1,000 classes in the ImageNet dataset is the output of the eighth and final layer.

AlexNet is trained via a random gradient descent with momentum.

The cross-entropy loss, which is the used loss function, is used to calculate the discrepancy between the predicted probability and the actual class labels. The model is trained for 90 epochs with a batch size of 128 and an initial learning rate of 0.01, and then it is decreased by a factor of 10 after 30 and 60 epochs.

The AlexNet CNN formula can be expressed as:

$$AlexNet(x)=FC3(FC2(FC1(CONV5(CONV4(CONV3(MAXPOOL2(CONV2(MAXPOOL1(CONV1(x))))))))))$$

where x is a input image,
CONV is a convolutional layer,
MAXPOOL is a max pooling layer,
FC is a fully connected layer.

The output layer has 1000 units, which is the same number of classes as the ImageNet dataset. The convolutional layers in AlexNet use a combination of 2D convolutions, pooling, and activation functions.

Convolution: The input to a convolutional layer is a tensor of shape (batch_size, input_height, input_width, input_channels). The layer applies a set of filters (kernels) to the input tensor to produce a set of output feature maps. K stands for the number of filters, while F stands for the size of each filter. The output feature maps have a height and width that are determined by size of the input feature maps, the filters size, the stride (S), and the amount of zero-padding (P). A convolutional layer's output tensor has shape. (batch_size, output_height, output_width, K).

ReLU activation: Following the convolution process, the output tensor's elements are each subjected to an element-by-element application of a Rectified Linear Unit (ReLU) activation function. The ReLU function returns the maximum of zero and the input value.

Pooling: The spatial dimension of the feature maps is decreased and overfitting is controlled thanks to the pooled output tensor's reduced height and breadth compared to the input tensor. Every map of features in the output tensor is subjected to the pooling procedure separately.

Max pooling: A set of rectangular pooling regions with size (pool_size, pool_size) and stride (S) are applied to each feature map in the output tensor. The result of the pooling process is the maximum value found in each pooling zone.

It uses the ReLU activation function which is represented by the formula

$$f(x) = \max(0, x)2.$$

The formula for a convolutional layer in AlexNet can be expressed as follows:

$$\text{output} = \text{ReLU}(\text{Convolution}(\text{input}, \text{filter}) + \text{bias})$$

where;
input: the input tensor of shape (batch_size, input_height, input_width, input_channels)
filter: the filter tensor of shape (filter_height, filter_width, input_channels, K)
bias: the bias tensor of shape (K,)
Convolution: the convolution operation with stride S and padding P
ReLU: the rectified linear unit activation function
output: the output tensor of shape

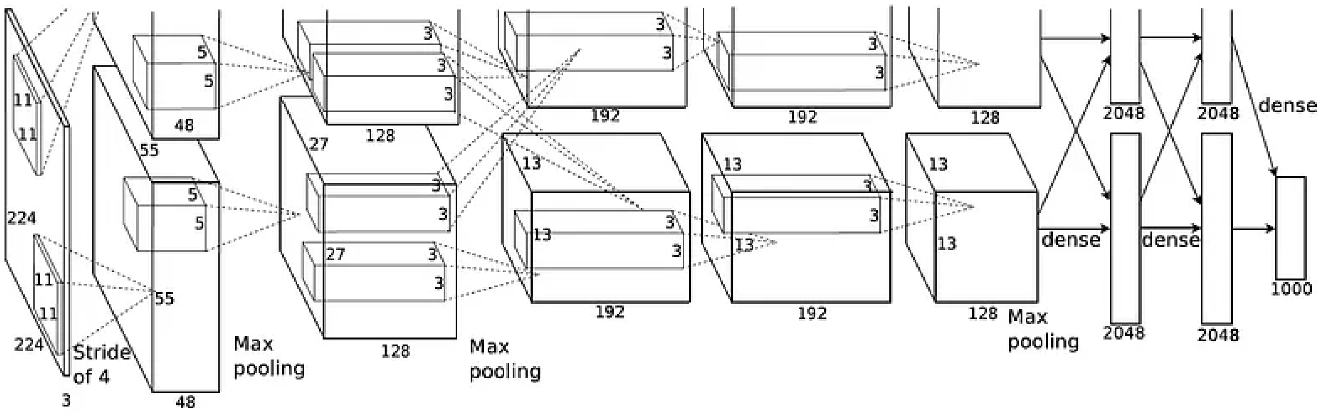

Figure 3. AlexNet architecture

Deploy the web application:

A server or cloud platform can be used to deploy the web application. A load of over 1000 users should be manageable for the web application at once.

Test the web application:

To make sure the web application is operating properly, it should be tested. Both unit testing and system testing should be performed during the testing.

VI. RESULTS

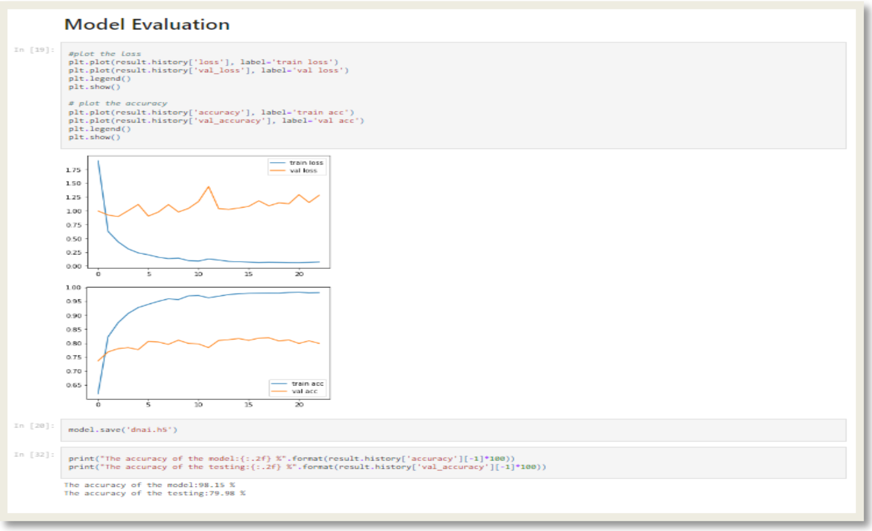

Figure 4. Performance

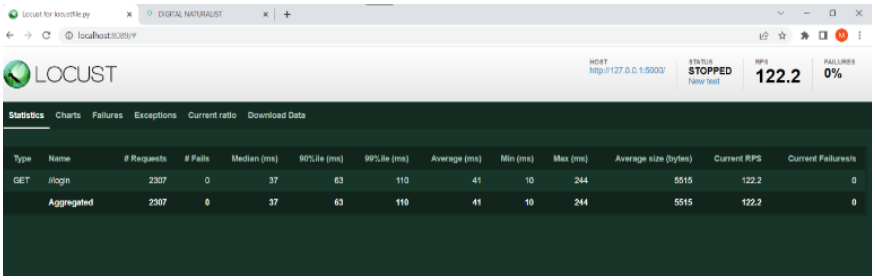

Figure 5. Performance using Locust tool

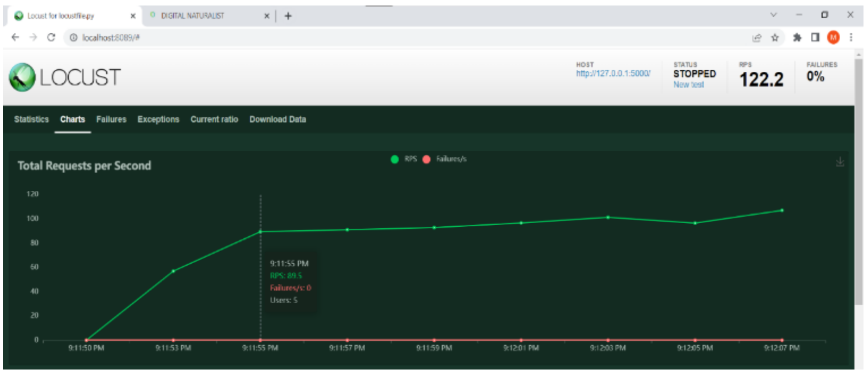

Figure 6. Locust test request analysis

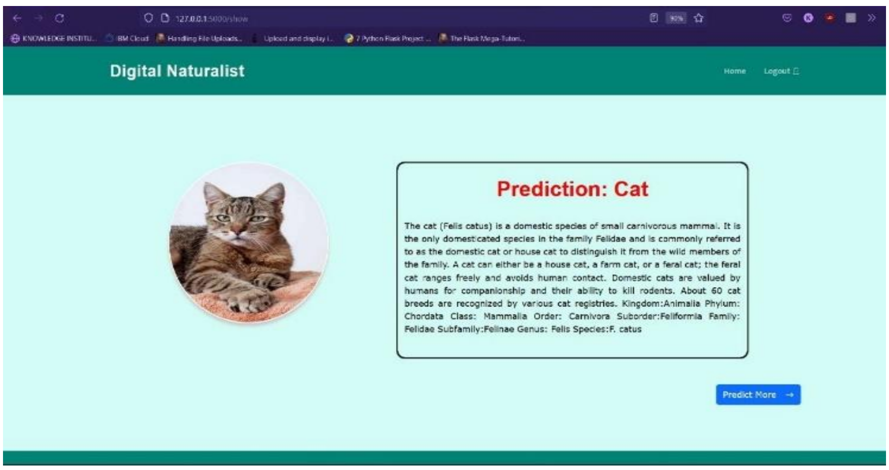

Figure 7. Animal prediction

Table I. Test case Analysis

SECTION	TOTAL CASES	NOT TESTED	FAIL	PASS
Print Engine	8	-	-	8
Client Application	10	-	-	10
Security	2	-	-	2
Exception Reporting	4	-	-	4
Final Report Output	3	-	-	3
Version Control	4	1	-	3

- In Figure 7, we can clearly see the output of our Digital Naturalist Using AI Software System.
- In Table I, we can see the Test Case Analysis. That table shows the number of test cases that have passed, failed, and untested.
- The model was built with an accuracy of 98.15%, and its performance accuracy and losses were plotted in the graph in Figure 4.
- In Figure 5,6 and Table I, we can see the results of our application tests, including how our application handles high loads and identifies potential performance bottlenecks.

VII. DISCUSSION

Problem Identification: Identify the issue that the domain of digital naturalists is trying to solve with your research. This can require detecting research gaps or investigating fresh deep learning applications.

Data Collection and Preprocessing: Collect and analyze the data you need to solve your research challenge. This can entail gathering and preparing photos, videos, or other data sources for use in the training and testing of your model.

Model Selection: Select the deep learning model that matches your research problem. You have decided on the AlexNet architecture in this case.

Hybrid Learning Algorithm Implementation: To train your AlexNet model, use a mixed learning approach. A hybrid learning algorithm may integrate several learning techniques, such as reinforcement learning , supervised and unsupervised or, in order to improve the performance of the model.

Model Training and Evaluation: Implementing the hybrid learning algorithm, train your model on the preprocessed data. Utilize relevant measures to assess the model's performance, including accuracy, precision, recall, and F1-score.

Results Analysis: Consider your model's performance in resolving your research challenge after analyzing the model's outcomes. This can involve comparing the performance of your model against current cutting-edge techniques in the field of digital naturalists.

Conclusion and Future Work: Evaluate your findings and suggest additional areas of analysis for future studies to enhance the functionality of your model or discover fresh uses for deep learning in the field of digital naturalists.

Our results show that when using simply supervised learning, a big, deep convolutional neural network is capable of breaking records on a highly challenging dataset. Even if one of the convolutional layers is removed, the network's performance won't be affected. For instance, the network's top-1 performance is reduced by about 2% when one or more middle layers are removed. The depth is therefore essential to obtaining our results. We did not use any unsupervised pre-training in order to simplify our experiments, even though we anticipate that it will be useful, especially if we are able to obtain enough computational power to significantly increase the size of the network without obtaining a corresponding increase in the amount of labelled data. In comparison to traditional models, the Digital naturalist tool has been shown to produce a higher accuracy rate of 98% in identifying plant and animal species from digital images. This high level of accuracy has the potential to revolutionize biodiversity research, making it possible to quickly and accurately identify new species, track changes in species populations, and monitor the impact of environmental factors on different species.

VIII. CONCLUSION

People would comprehend the intrinsic or other significance of our state's imperiled biodiversity in the new era of extinction. There would be less natural world observations, data points, and discoveries to aid in measuring our impacts on it. It offers the chance to develop a positive identity with science or to appreciate the worth of more all-encompassing modes of thinking, like conventional ecological knowledge. It enables us to take part in environmental stewardship activities like resource preservation and the development of community resilience in sensitive areas. The naturalist viewpoint strengthens our sense of connection with the other species we share this world with and our desire to protect and nurture it by recognizing our evolutionary roots. Humanity and all other sentient beings are dependent on conditions that exist in a universe that is much larger than our own in both space and time. The model that was used to find digital naturalists utilizing photographs of wild species, species with a flora component, and species with a fauna component will also be shown. It is evident from the resulting graphs that the model's accuracy has improved to a respectable level. If it is used in a real-time setting, many individuals will be able to discern between the two without spending money on several devices. If the model supports the photograph, the user can determine the species' characteristics. It may be the most effective method for people to save money. If the data is more detailed and precise about the species, which is what any deep learning model strongly rely on, it may help achieve more accuracy and better outcomes in real-time applications.

IX. FUTURE SCOPE

Monitoring biodiversity is crucial so that we can spot changes and deduce the causes of those changes in light of recent findings indicating a reduction in global biodiversity. Although social media images and other online digital media may be a new source of biodiversity observations, there are simply too many of them for a human to practically review. Combining the arts and technology can foster relationships in historic gardens and foster compassion for non-human animals. species' geographical identity and origin information. Statistical comparison of ML based quality estimators is treated as a multi-dimensional problem in the proposed guidelines. In order to quantify the practical importance of the observed differences, we want to evaluate the predictors more comprehensively in terms of their local performance on certain test conditions, their capacity for learning, and the size of the treatment effect. The existing method, however, tries to simplify this process to binary and global statistical decision-making and does not expose the predictors' underlying systematic strength (or weakness). Software that carries out the suggested rules is made accessible to the public in order to give users a tool for practical application. We have seen some progress in our results as our network has grown and been trained longer, but we still have a long way to go before we can match the inferotemporal pathway of the human visual system.

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