



Digital Naturalist - AI Enabled tool for Biodiversity Researchers

A PROJECT REPORT

Submitted by

Abishek M	712219205001
Deenadhayalan E	712219205005
Deepan S	712219205006
KarthikSelvan M	712219205018

Team ID-PNT2022TMID42852

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BONAFIDE CERTIFICATE

Certified that this project report “**Digital Naturalist - AI Enabled tool for Biodiversity Researchers**” is the bonafide work of “**Abishek M, Deenadhayalan E, Deepan S, KarthikSelvanM**” who carried out the project work under my supervision. Our Team ID-**PNT2022TMID42852**.

Dr.B.Padmanabhan

Mr.G.Prabanchan

HEAD OF THE DEPARTMENT

MENTOR

Professor

Assistant professor

Information Technology

Information Technology

Park College of Engineering
and Technology,

Park College of Engineering
and Technology,

Kaniyur,

Kaniyur,

Coimbatore-641659

Coimbatore-641659

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1. INTRODUCTION

1.1 Project Overview

A naturalist is someone who studies the patterns of nature, identifies a different kind of flora and fauna in nature. Being able to identify the flora and fauna around us often leads to an interest in protecting wild spaces, and collecting and sharing information about the species we see on our travels is very useful for conservation groups like NCC.

When venturing into the woods, field naturalists usually rely on common approaches like always carrying a guidebook around everywhere or seeking help from experienced ornithologists. There should be a handy tool for them to capture, identify and share the beauty to the outside world.

In this project, we are creating a web application which uses a deep learning model, trained on different species of birds, flowers and mammals (2 subclasses in each for a quick understanding) and get the prediction of the bird when an image is been given.

1.2 Purpose

- Augmenting a dataset to virtually increase the size of small datasets in order to make our machine learning models work better.
- Preprocess the images to a machine-readable format.
- Applying CNN algorithm on the dataset.
- How deep neural networks are predicting the class and subclass of a given image.
- You will be able to know how to find the accuracy of the model.
- You will be able to build web applications using the Flask framework.

2. LITERATURE SURVEY

2.1 Existing problem

Biases in our data arise in part from differences between the aims of the original data collectors (i.e., the photographers) and our aims as biodiversity researchers and ecologists. For example, the spatial distribution of our images was biased toward areas where extensive managed gardens or other displays exhibited large collections of flowering plants. These biases could be addressed by choosing alternative sources, changing the search terms used, or pre-filtering images. Images may also be biased taxonomically or in terms of certain traits, for example, toward species that are typically considered more photogenic due to large colorful flowers or leaves. Search terms could be modified to either focus on a specific sub-group, e.g., searching using scientific names, or to exclude non-target images, e.g., excluding images that include the words “show” or “garden” in their metadata. Finally, high-level image classifiers could be trained to remove images that are clearly not plants, e.g: removing images of animals, paintings. High-level classifiers developed to separate images that contain plants from those that do not, without looking to identify species, could be used to find images worthy of further examination in large datasets that do not have metadata (such as titles and descriptions), removing the need for keyword searches, such as that used in this study.

2.2 References

[1] Aldhebiani AY (2018) Species concept and speciation. Saudi J Biol Sci 25:437–440.

[2] AI naturalists might hold the key to unlocking biodiversity data in social media imagery,

TA August, OL Pescott, A Joly, P Bonnet - Patterns, 2020 - Elsevier.

[3] Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet, ME

Mondejar, R Avtar, HLB Diaz, RK Dubey... - Science of the Total ..., 2021 - Elsevier

[4] The real-world use of big data, M Schroeck, R Shockley, J Smart, D Romero-Morales...

- IBM Global Business ..., 2012

2.3 Problem Statement Definition

- **Main Problem statement (common):**

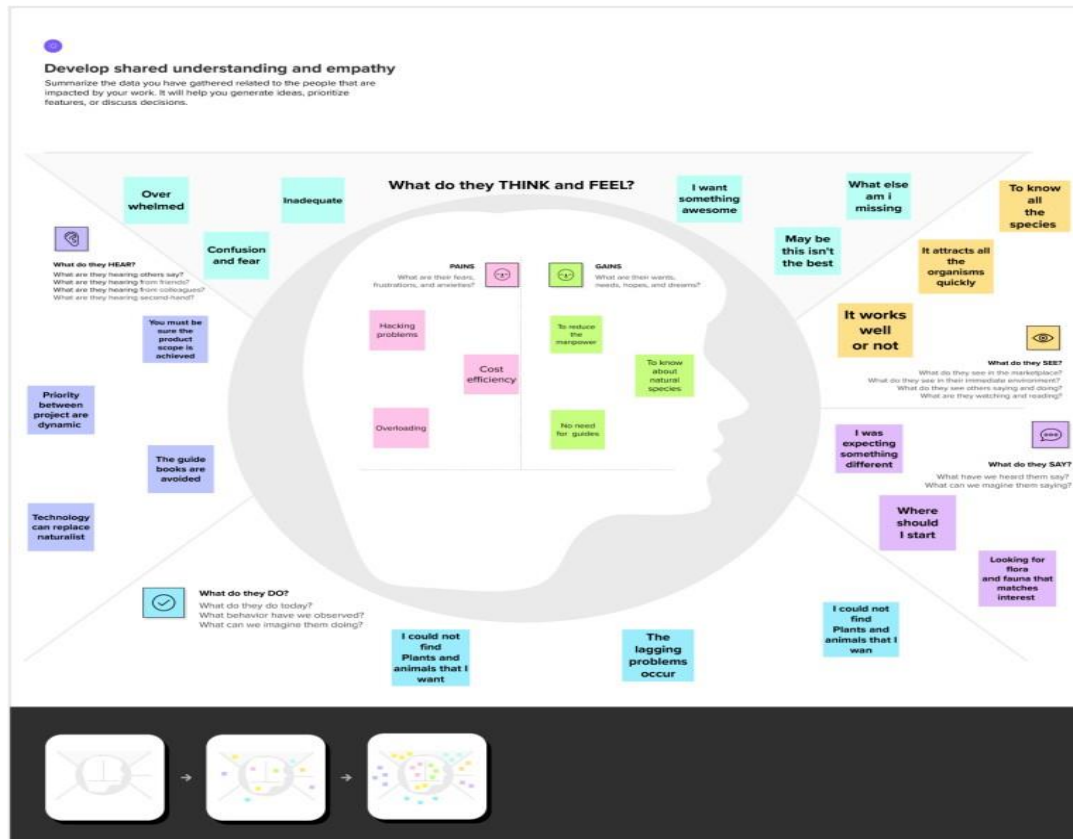
- I. How might we help both experienced and inexperienced user to identify species of plants and animals and their characteristics with related information?

- **Specific problem statement:**

- i) Inexperienced users need to know about poisonous plants and dangerous animals so that they can stay away from it.
- ii) Both experienced and inexperienced users need to know about the medicinal values of a plant because they need to use it in case of emergencies.
- iii) All the users need to know the types of species of birds, plants and animals so that they can learn about it in more detailed manner.
- iv) All the users need to know about the rarity of the species of birds, animals or plants so that they can preserve and save it.


3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

Template



Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

⌚ 10 minutes to prepare
👥 4 hours to collaborate
👤 2-6 people recommended

[Share template feedback](#)

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

⌚ 10 minutes

A

Team gathering

Outline who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B

Set the goal

Think about the problem you'll be focusing on solving in the brainstorming session.

C

Learn how to use the facilitation tools

Use the Facilitation Superpowers to run a happy and productive session.

[Open article](#)

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

⌚ 5 minutes

PROBLEM

How might the biodiversity researcher identify different species of flora and fauna in some wild spaces for his research purpose?

Key rules of brainstorming

To run an smooth and productive session

Stay on topic


Encourage wild ideas

Defer judgement

Listen to others

Go for volume

If possible, two visual



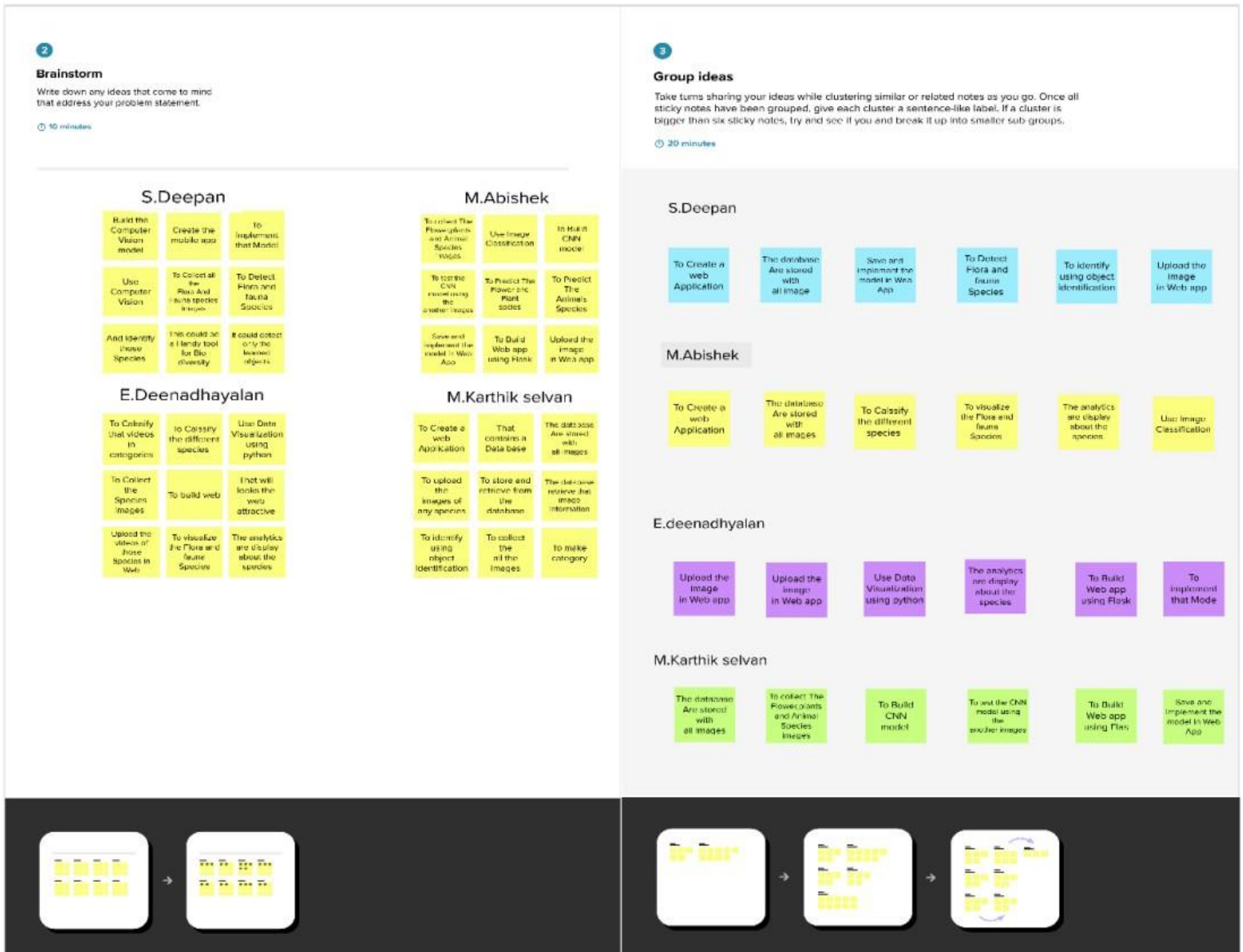
Need some inspiration?

Get a random prompt or idea for your session. Refresh your ideas.

[Open examples](#)

Step-1: Team Gathering, Collaboration and Select the Problem Statement

8

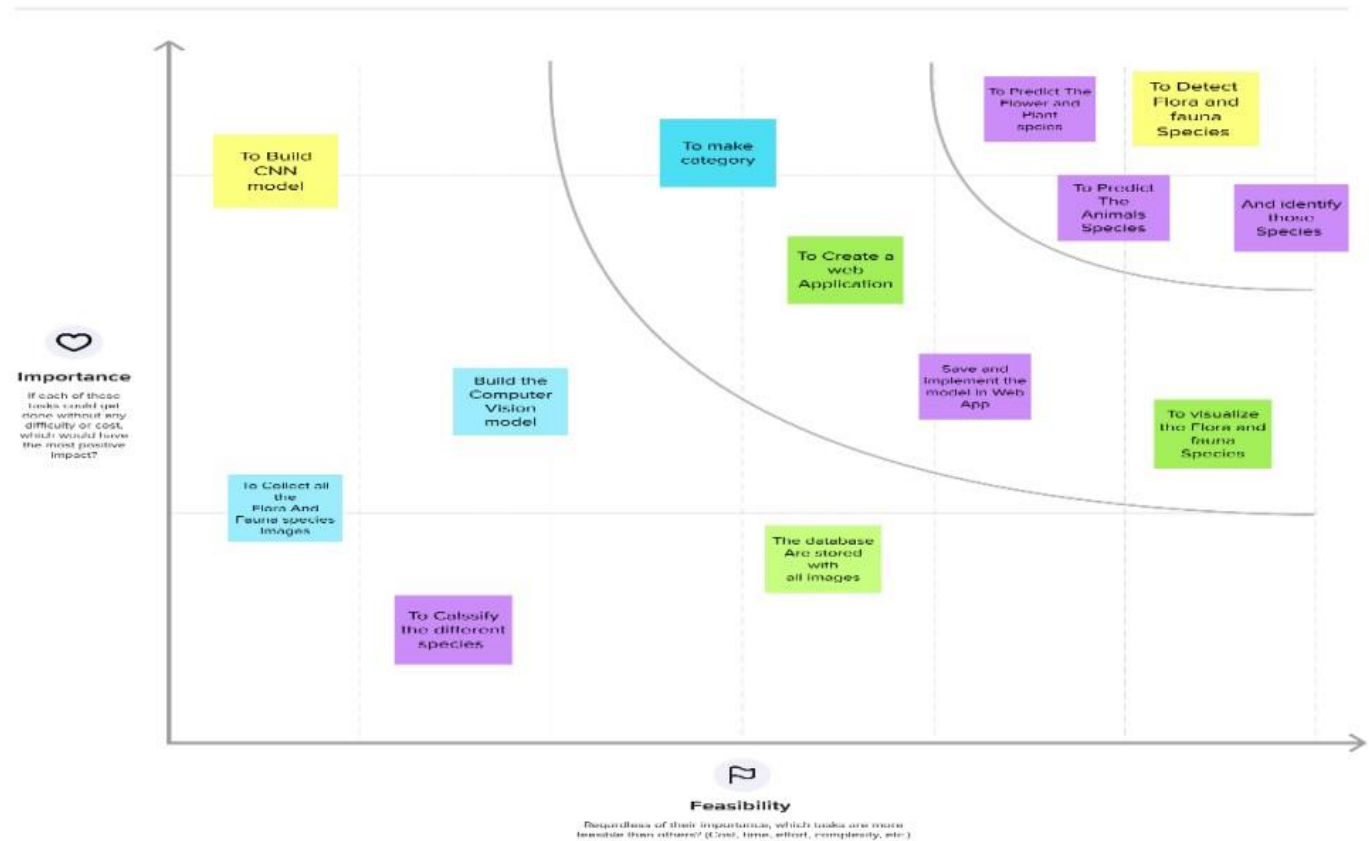


4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

🕒 20 minutes



Step-3: Idea Prioritization

3.3 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	<p>i) How might we help both experienced and inexperienced user to identify species of plants and animals and their characteristics with related information?</p> <p>ii) Inexperienced users need to know about poisonous plants and dangerous animals so that they can stay away from it.</p> <p>iii) Both experienced and inexperienced users need to know about the medicinal values of a plant because they need to use it in case of emergencies.</p> <p>iv) All the users need to know about the rarity of the species of birds, animals or plants so that they can preserve and save it.</p>
2.	Idea / Solution description	<p>i) Display Botanical names</p> <p>ii) Display alert messages for plants/animals using different colours</p> <p>iii) small description about them</p> <p>iv) Rarities of the species</p> <p>v) What disease does the plant cure</p>
3.	Novelty / Uniqueness	<p>i) Providing alerts based on if a species is harmful or not</p> <p>ii) Alerting the user on the rarity of the species</p> <p>iii) Gives the complete description about the species being viewed</p> <p>iv) If the plant being viewed has a medicinal value , it gives a description about it.</p> <p>v) Display the scientific name of the species.</p>
4.	Social Impact / Customer Satisfaction	Being able to identify the flora and fauna around us often leads to an interest in protecting wild spaces.
5.	Business Model (Revenue Model)	<p>i) Can make money through subscription based.</p> <p>ii) Partnership with many laboratories and scientists around the world</p>
6.	Scalability of the Solution	<p>i) As the usage and user base of this application grows more feature can be added to the premium or subscription model.</p> <p>ii) We can introduce subscription models like free plan, business plan, educational plan and many more based on its usage</p> <p>iii) As the usage increase we can scale the application by releasing more languages based on the geographical usage.</p>

3.4 Problem Solution fit

Define CS, fit into CC	1. CUSTOMER SEGMENT(S) CS <ul style="list-style-type: none"> Ornithologist Students Hikers Migrators Biologist Zoologist Tourister Research people 	6. CUSTOMER CONSTRAINTS CC <ul style="list-style-type: none"> Network issues Insufficient knowledge about the biodiversity. Cannot remember all the basic life saving tips Making observations among species. 	5. AVAILABLE SOLUTIONS AS <ul style="list-style-type: none"> Need to always carry a guidebook around everywhere Internet databases where we must search for certain species from the mountain of images from the web using modern algorithms. Usage of ai to tackle different complex difficulties in the wildlife. 	Explore AS, differentiate
	2. JOBS-TO-BE-DONE / PROBLEMS J&P <ul style="list-style-type: none"> Unable to identify sub species of certain amphibians or birds. Cannot find a suitable place to work in the workplace Cannot find the exact habitat of certain species. 	9. PROBLEM ROOT CAUSE RC <ul style="list-style-type: none"> complexities in identification Information gathering Need to depend on external resources Large dataset Money problem Depend upon Guide 	7. BEHAVIOUR BE <ul style="list-style-type: none"> Volunteering for jobs where we can actively work with wildlife Finding rare and endangered species of flora and fauna and help them navigate in current 	
Identify strong TR & EM	3. TRIGGERS TR <ul style="list-style-type: none"> Save nature Save Endangered Species Expanding the lifespan of certain species through medicine Helps to gather aerial species away from places where they are prone to tower kill or other dangers 	10. YOUR SOLUTION SL <ul style="list-style-type: none"> It can be in offline mode All Information about the Species should be displayed. Medical Benefits of different plants can be displayed. Display alert messages for plants/animals Display alert messages for plants and animals. 	8. CHANNELS of BEHAVIOUR CH 8.1 ONLINE <ul style="list-style-type: none"> Capture image and search it Browse using the internet 8.2 OFFLINE <ul style="list-style-type: none"> Hand notes Getting the information from experienced user 	Identify strong TR & EM
	4. EMOTIONS: BEFORE / AFTER EM <ul style="list-style-type: none"> Co2 to o2 Imbalanced world to sustainable world Accumulation of waste to renewable energy 			

4. REQUIREMENT ANALYSIS

(Following are the functional & non-functional requirements of the proposed solution)

4.1 Functional requirement.

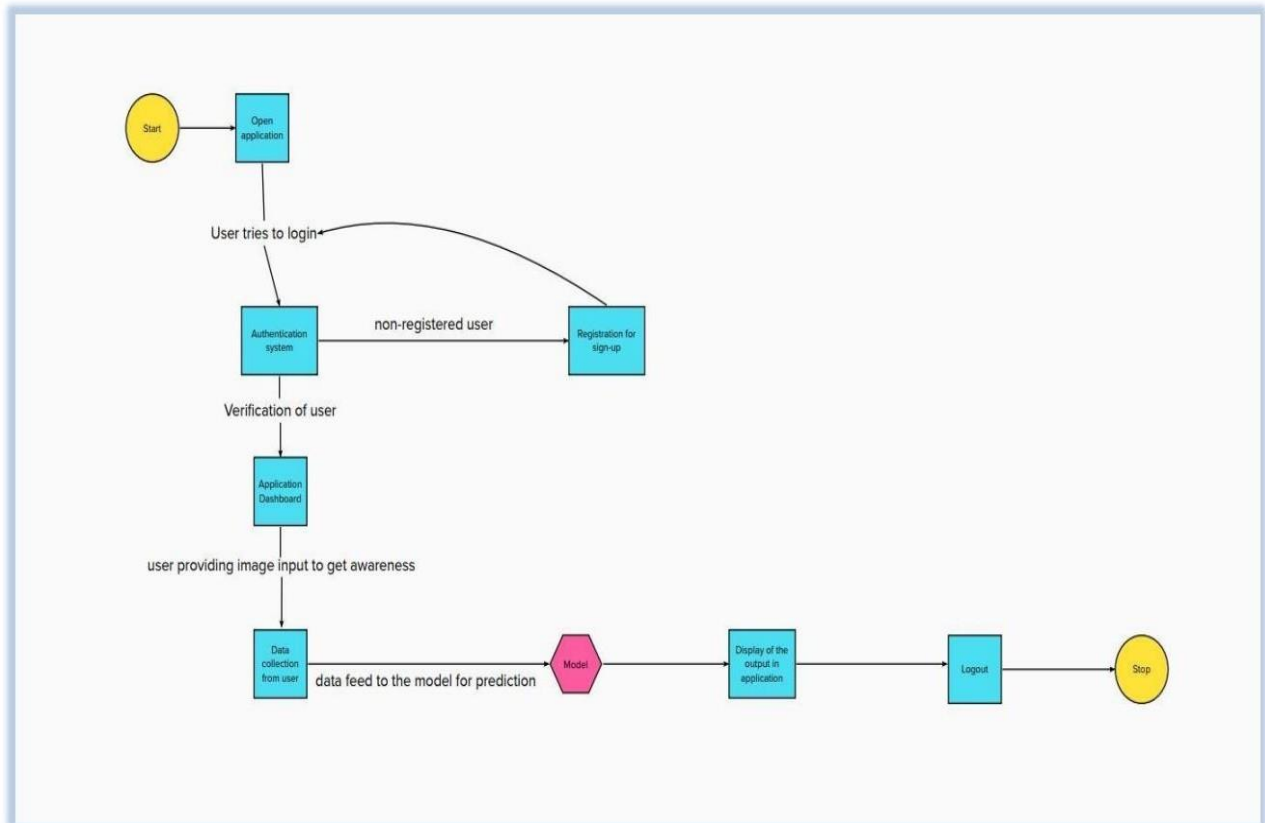
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Navigation Service	GPS
FR-4	Database	My SQL, IBM Cloud
FR-5	Premium features	Location sharing, Adding information of new data by User
FR-6	Updating and bug fixing	Updating the application based on user feedback
FR-7	Final Output	Final description of the image (species) captured.
FR-8	Alerts	System should alert about dangerous plants and animals

4.2 Non-functional Requirements.

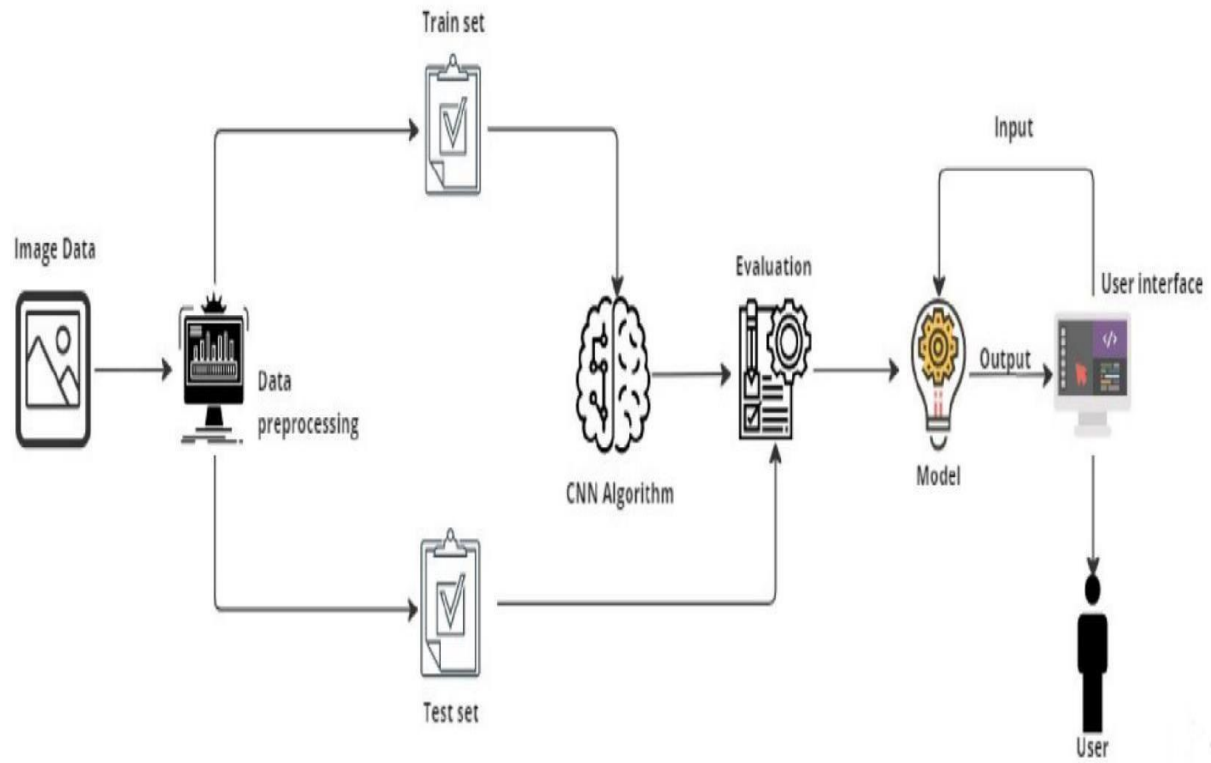
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The users must be able to use the application without any problems and difficulties. The app is easy to view and does not strain the eyes. All information are in simple terms. The error rate of the final output must not be more than 20%
NFR-2	Security	SHA-256, Encryptions, AES etc.
NFR-3	Reliability	The system must perform without failure in 80 percent of the time.
NFR-4	Performance	Under normal load, the system must show the results within 15 seconds, and under maximum it can take up to load 30 seconds
NFR-5	Availability	The application will be available 99 % of the time in a month.
NFR-6	Scalability	The system must be able to support 10,000 users while using it. As the usage and user base of this application grows, more features can be added like languages based on the geographical usage, premium or subscription model, etc.

5. PROJECT DESIGN

5.1 Data Flow Diagrams



Solution & Technical Architecture



5.2 User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority
Customer (Mobile user)	Image capture	USN-1	As a user, I can take photos of the plantlife, animals and birds	I can take photos whenrequired	High
		USN-2	As a user, I will receive processed information about the type of species	I can see the type of plant or animal or plant	High
		USN-3	As a user, I can share it with others	I can share using shareoption	Low
	Data process	USN-4	Data must be trained and tested and CNN algorithm must work properly.	I must see the correct processed information	High
	Output	USN-5	As a user, I can see the scientific nameof the species	I must see the correctdata	High
		USN-6	As a user, I can see the characteristicsand alert messages	I must see the correctdata	High
Administrator	Manage	USN-1	As a admin I must add various data andedit information	I must edit the datapresent	High

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a biogeography, I can register for the application by entering my Email, Password, and confirming my password	2	High	Deepan S Abishek M Deenadhyalan Karthikselvan
Sprint-1	User Confirmation	USN-2	As a biogeography, I will receive confirmation email once I have registered for the application	1	Medium	Deepan S Abishek M Deenadhyalan Karthikselvan
Sprint-1	Login	USN-3	As an biogeography, I can log into the application by entering email & password	2	High	Deepan S Abishek M Deenadhyalan Karthikselvan
Sprint-2	Data Collection	USN-1	Download the dataset used in Digital Naturalist – AI Enabled tools for Biodiversity Researchers	2	Medium	Deepan S Abishek M Deenadhyalan Karthikselvan
Sprint-2	Image Preprocessing	USN-1	Improving the image data that suppresses unwilling distortions or enhances some image features important for further processing, although performing some geometric transformations of images like rotation, scaling, etc.	1	High	Deepan S Abishek M Deenadhyalan Karthikselvan
Sprint-3	Getting started with Convolutional Neural Network	USN-1	Neural network are integral for teaching computers to think and learn by classifying information, similar to how we as humans learn. With neural networks, the software can learn to recognize images, for example. Machines can also make predictions and decisions with a high level of accuracy based on		Medium	Deepan S Abishek M Deenadhyalan Karthikselvan














			data inputs.			
Sprint-3	Evaluation and model saving	USN-1	well a model behaves after each iteration of optimization. An accuracy metric is used to measure the algorithm's performance in an interpretable way. The accuracy of a model is usually determined after the model parameters and is calculated in the form of a percentage. Saving The Model get weights , set weights .	1	Medium	Deepan S Abishek M Deenadhyalan Karthikselvan
Sprint-4	Application Building	USN-2	After the model is built, we will be integrating it to a web application so that normal users can also use it. The users need to give the images of species	1	High	Deepan S Abishek M Deenadhyalan Karthikselvan
Sprint-4	Train the Model on IBM	USN-2	Build Deep learning model and computer vision Using the IBM cloud.	2		Deepan S Abishek M Deenadhyalan Karthikselvan

6.2 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart:

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as onPlanned End Date)	Sprint Release Date (Actual)
Sprint-1	20	4 Days	24 Oct 2022	27 Oct 2022	20	29 Oct 2022
Sprint-2	20	5 Days	28 Oct 2022	01 Nov 2022	20	04 Nov 2022
Sprint-3	20	7 Days	02 Nov 2022	09 Nov 2022	20	11 Nov 2022
Sprint-4	20	9 Days	10 Nov 2022	18 Nov 2022	20	19 Nov 2022

6.3 Reports from JIRA

	OCT	NOV
Sprints	DIG S...	DIG S... DIG S... DIG S... DIG S...
▼ ⚡ DIG-9 Resigtration 📌 DIG-1 As a user, I can regis... DONE VIMOSH A... 📌 DIG-2 As a user, I will receiv... DONE SYED ABR... 📌 DIG-3 As a user, I can regist... DONE 4042- SIV... 📌 DIG-4 As a user, I can regist... DONE DEVSWA94	    	
▼ ⚡ DIG-17 Login 📌 DIG-18 As a user,I can log i... DONE SYED ABR...		 
▼ ⚡ DIG-19 Dashboard 📌 DIG-6 As a user, I will explor... DONE SYED ABR... 📌 DIG-7 As a user, I will perfo... DONE VIMOSH A...		  
▼ ⚡ DIG-20 Input/Output 📌 DIG-8 As a user, I will give t... DONE SYED ABR... 📌 DIG-11 As a user, I can get... DONE VIMOSH A...		  

7. CODING & SOLUTIONING

7.1 Feature 1:

- Display Botanical names
- Display alert messages for plants/animals using different colors
- small description about them
- Rarities of the species

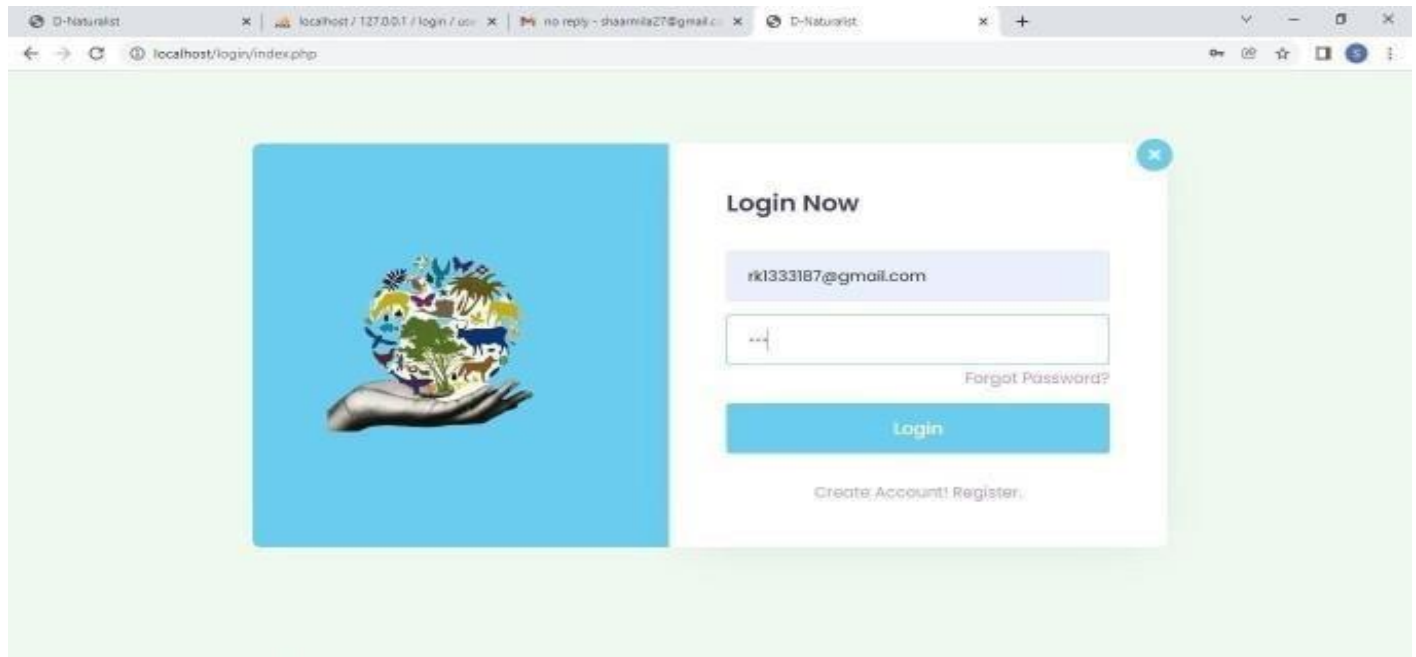
7.2 Feature 2:

- What disease does the plant cure
- Providing alerts based on if a species is harmful or not

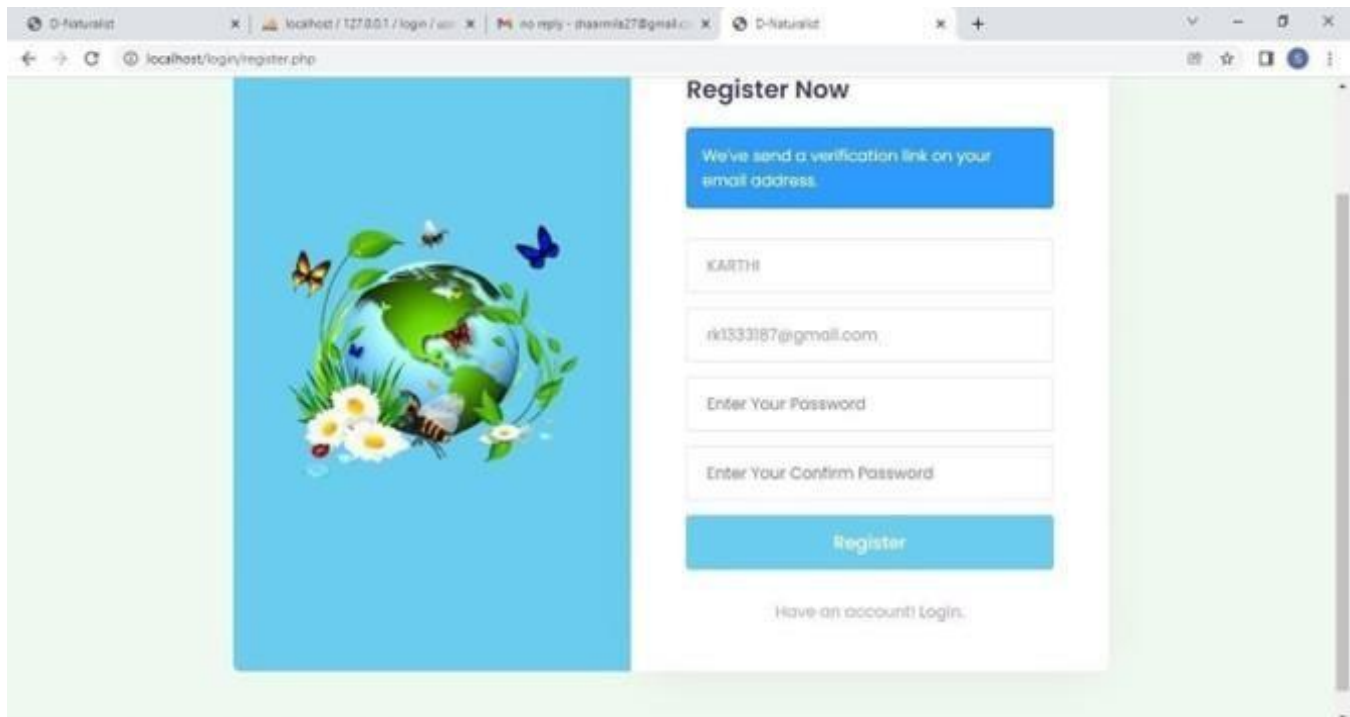
8. RESULTS

8.1 Performance Metrics

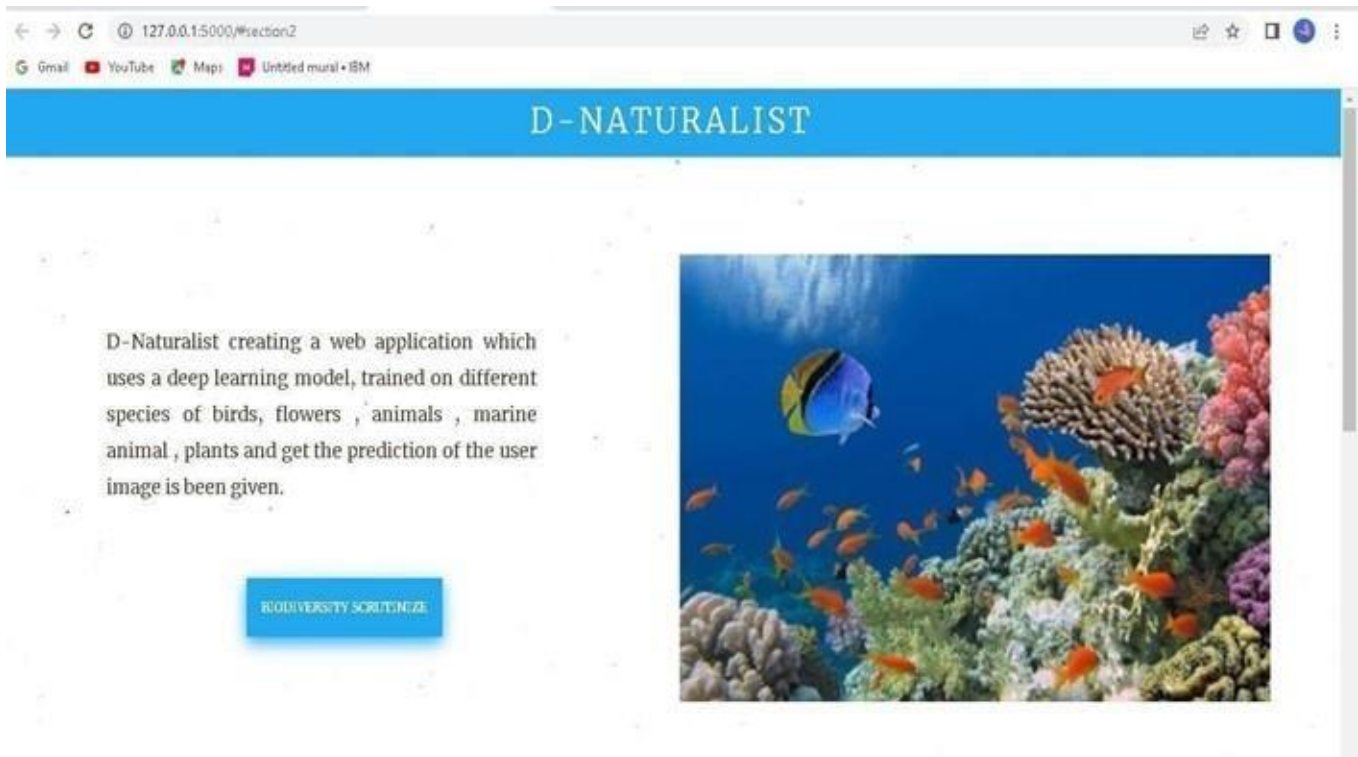
Registration Page:



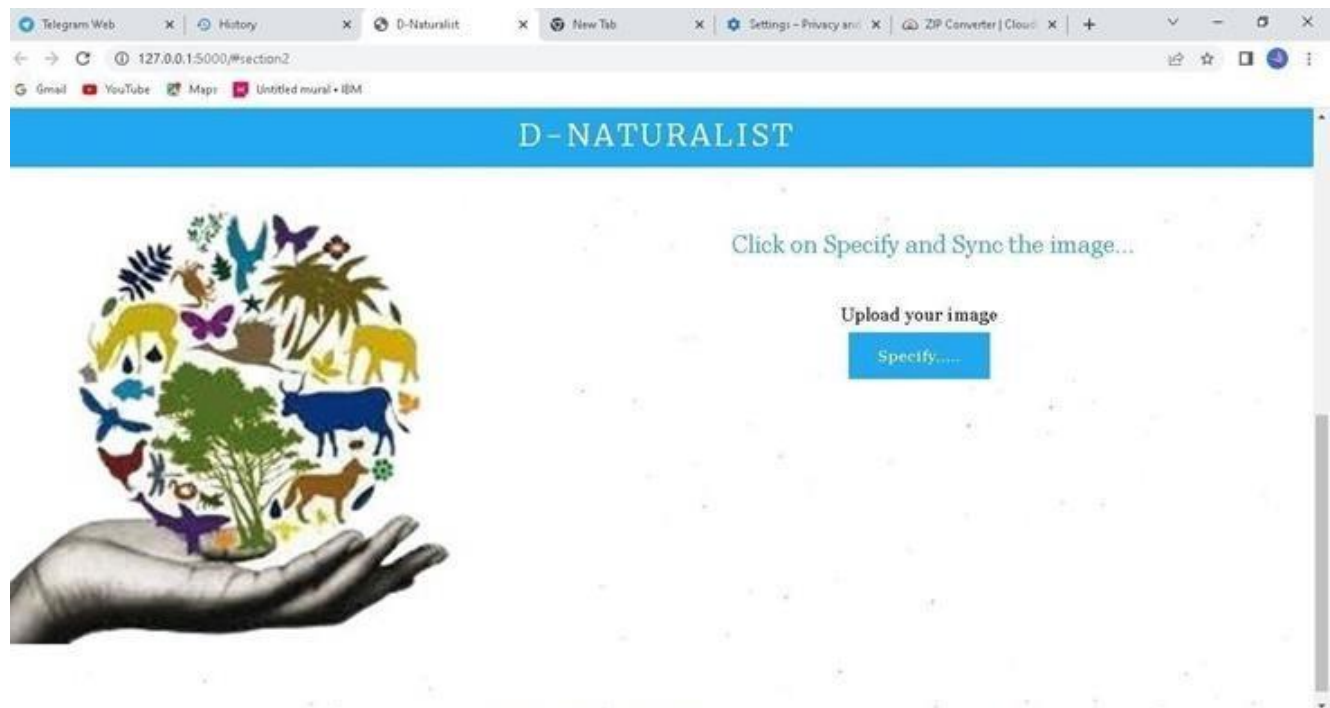
Login Page :



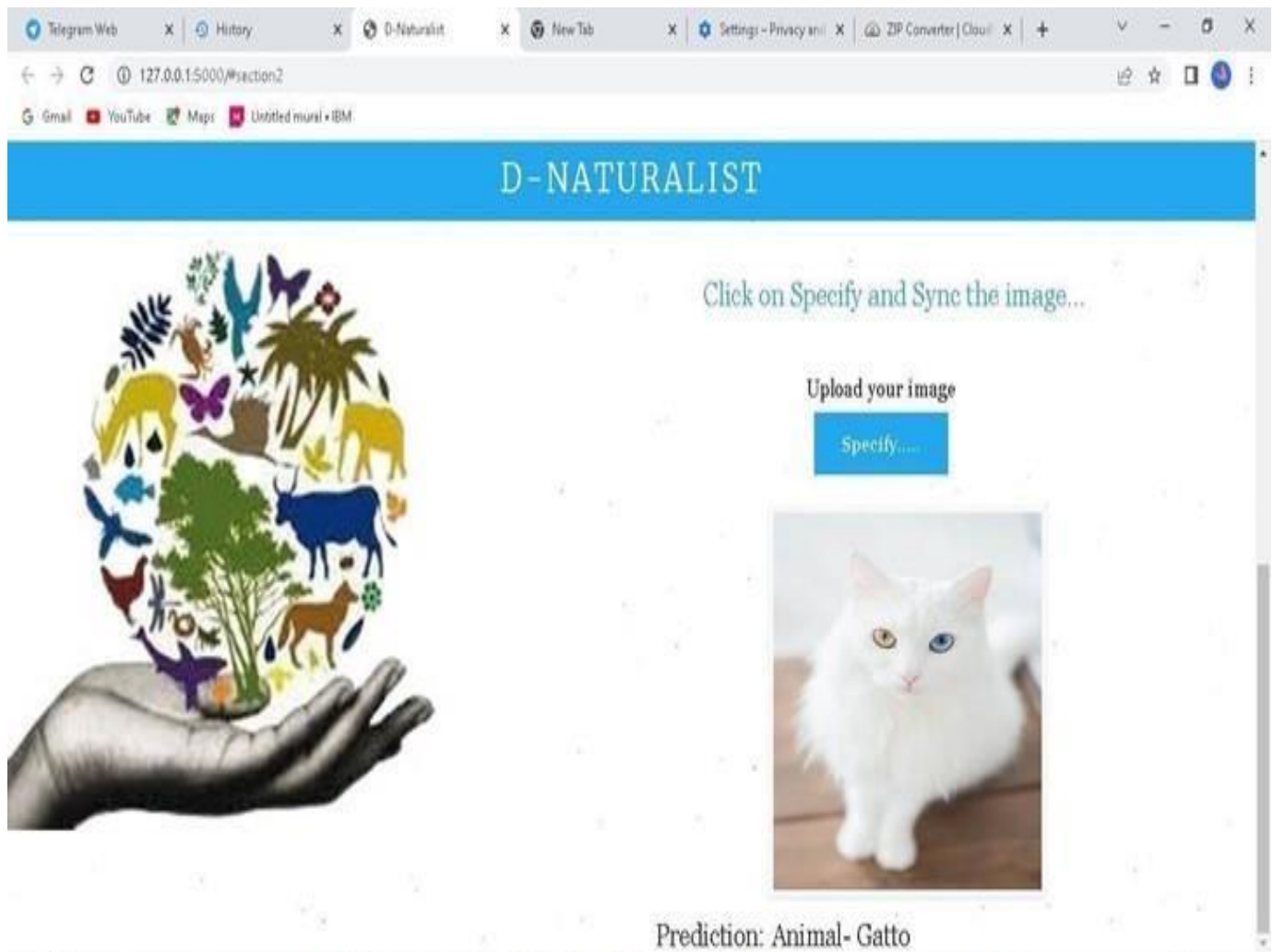
Home Page(Dashboard):



Input:



Output:



9. ADVANTAGES & DISADVANTAGES

Advantages:

- It helps field biologists build their own experimental tools.
- It helps designers explore new interactions with nature.
- It paved the ways to discover new ways of experiencing the natural world.
- It helps to create sustainable world by saving the endangered species.
- Digital Naturalism unites biologists, designers, engineers, and artists to build and analyze new devices.
- User can get detailed description of any kind of species.
- It is a handy application for a person who is travel freak.

Disadvantages:

- Proper network should be maintained to avoid hitches.
- Difficult to classify sub-classes of same species.

Assessment of regional biodiversity based on global scientific consensus is a scientific basis for the whole society and a tool for local to international discussion and decision making. In the new era of extinction, people would understand the value of (intrinsic or otherwise) of our state's threatened biodiversity. Fewer observations, data points and discoveries would be made of the natural world to help us measure our impacts on it. It provides the opportunity to build a positive identity with science or recognize the value of more holistic ways of thinking such as traditional ecological knowledge. It helps us to engage in environmental stewardship behaviours ranging from resource conservation to building resilience among vulnerable communities. By acknowledging our origins in evolution, the naturalist perspective also enhances our feeling of kinship with the other species with which we share this planet, and our desire to sustain and nurture the planet itself. All sentient beings, including humanity, owe their existence to conditions that extend far beyond us in space and time. The model which was used for the detection of digital naturalists using the species images from the wild life and the species with flora part and with fauna part will be displayed as well. From the resultant graphs, it is proven that the accuracy of the model has reached good level. If it is deployed in the real-time scenario then it will help many people in distinguishing between both without wasting the money on various machines. If the image is confirmed by the model, then the person can know the feature of the species. It can be the best way of practice for people to save money. As we know that the data plays a crucial role in every deep learning model, if the data is more specific and accurate about the species then that can help in reaching greater accuracy with better results in real- time applications.

11.

FUTURE SCOPE

- **AI image classifiers can create biodiversity datasets from social media imagery**
- **Flickr hosts many images of plants; some can be accurately classified to species by AI**
- **Images are spatially aggregated around tourist sites and under-represent native species**
- **Images focused on a single, non-horticultural, plant are most reliably**

Source Code

```

<----- # index1.php ----->
<?php
    session_start();
    if (isset($_SESSION['SESSION_EMAIL'])) {
        header("Location: welcome.php");
        die();
    }

    include 'config.php';
    $msg = "";

    if (isset($_GET['verification'])) {
        if (mysqli_num_rows(mysqli_query($conn, "SELECT * FROM users WHERE
code='{$_GET['verification']}'") > 0) {
            $query = mysqli_query($conn, "UPDATE users SET code=" WHERE
code='{$_GET['verification']}'");

            if ($query) {
                $msg = "<div class='alert alert-success'>Account verification has been successfully
completed.</div>";
            }
        } else {
            header("Location: index.php");
        }
    }

    if (isset($_POST['submit'])) {
        $email = mysqli_real_escape_string($conn, $_POST['email']);
        $password = mysqli_real_escape_string($conn, md5($_POST['password']));

        $sql = "SELECT * FROM users WHERE email='{ $email }' AND password='{ $password }'";
        $result = mysqli_query($conn, $sql);

        if (mysqli_num_rows($result) === 1) {
            $row = mysqli_fetch_assoc($result);

            if (empty($row['code'])) {
                $_SESSION['SESSION_EMAIL'] = $email;
                header("Location: welcome.php");} else {

```

```

    $msg = "<div class='alert alert-info'>First verify your account and try again.</div>";
  }
} else {
  $msg = "<div class='alert alert-danger'>Email or password do not match.</div>";
}
}
?>

```

```

<!DOCTYPE html>
<html lang="zxx">

```

```

<head>

```

```

  <title>Digital Naturalist- </title>
  <!-- Meta tag Keywords -->
  <meta name="viewport" content="width=device-width, initial-scale=1">
  <meta charset="UTF-8" />
  <meta name="keywords"
    content="Login Form" />
  <!-- //Meta tag Keywords -->

```

```

  <link href="//fonts.googleapis.com/css2?family=Poppins:wght@300;400;500;600&display=swap"
rel="stylesheet">

```

```

  <!--/Style-CSS -->
  <link rel="stylesheet" href="css/style.css" type="text/css" media="all" />
  <!--//Style-CSS -->

```

```

  <script src="https://kit.fontawesome.com/af562a2a63.js" crossorigin="anonymous"></script>

```

```

</head>

```

```

<body>

```

```

  <!-- form section start -->
  <section class="w3l-mockup-form">
    <div class="container">
      <!-- /form -->
      <div class="workinghny-form-grid">
        <div class="main-mockup">
          <div class="alert-close">
            <span class="fa fa-close"></span>
          </div>
          <div class="w3l_form align-self">
            <div class="left_grid_info">

```

```

        </div>
    </div>
    <div class="content-wthree">
        <h2>Login Now</h2>
        <p>Lorem ipsum dolor sit amet consectetur adipisicing elit. </p>
        <?php echo $msg; ?>
        <form action="" method="post">
            <input type="email" class="email" name="email" placeholder="Enter Your Email"
required>
            <input type="password" class="password" name="password" placeholder="Enter Your
Password" style="margin-bottom: 2px;" required>
            <p><a href="forgot-password.php" style="margin-bottom: 15px; display: block; text-align:
right;">Forgot Password?</a></p>
            <button name="submit" name="submit" class="btn" type="submit">Login</button>
        </form>
        <div class="social-icons">
            <p>Create Account! <a href="register.php">Register</a>.</p>
        </div>
    </div>
</div>
</div>
<!-- //form -->
</div>
</section>
<!-- //form section start -->

<script src="js/jquery.min.js"></script>
<script>
    $(document).ready(function (c) {
        $('.alert-close').on('click', function (c) {
            $('.main-mockup').fadeOut('slow', function (c) {
                $('.main-mockup').remove();
            });
        });
    });
</script>

</body>

</html>

```

<----- # **app.py** ----->

```
from __future__ import division, print_function

import os

import numpy as np

import tensorflow as tf

from tensorflow.keras.preprocessing import image

from tensorflow.keras.models import load_model

from flask import Flask, request, render_template

from werkzeug.utils import secure_filename

global graph

#graph=tf.get_default_graph()

# Define a flask app

app = Flask(__name__)

model = load_model('nature1.h5')

print('Model loaded. Check http://127.0.0.1:5000/')

@app.route('/', methods=['GET'])

def index():

    # Main page

    return render_template('digital.html')

@app.route('/predict', methods=['GET', 'POST'])

def upload():

    if request.method == 'POST':

        # Get the file from post request

        f = request.files['image']

        # Save the file to ./uploads

        basepath = os.path.dirname(__file__)

        file_path = os.path.join(basepath, 'uploads', secure_filename(f.filename))

        f.save(file_path)img = image.load_img(file_path, target_size=(64,64))
```



```

x = image.img_to_array(img) x
= np.expand_dims(x, axis=0)

#with graph.as_default():

preds = np.argmax(model.predict(x))

found = ["animal- badger",
"animal- bat",
"animal- bear",
"animal- bee",
"animal- dolphin",
"animal- donkey",
"animal- dragonfly",
"animal- duck",
"animal- eagle",
"animal- elephant",
"animal-flamingo",
"animal-fly",
"animal-fox",
"animal- gallina",
"animal- gatto",
"animal- hedgehog",
"animal- hippopotamus",
"animal- hornbill",
"animal- horse",
"animal- hummingbird"]

print(preds)

text = found[preds]

```

```
if __name__ == '__main__':  
    app.run(threaded = False)
```

GitHub & Project Demo Link

GitHub Link : [Click Here](#)

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