DIGITAL NATURALIST - AI ENABLED TOOL FOR BIODIVERSITY RESEARCHERS

CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

A naturalist is someone who studies the patterns of nature, identifies 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 species, and collecting and sharing information about the species we see on our travels is very useful for conservation groups like NCC.We use artificial neural network to train these image and build a deep learning model. 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.

1.2 PURPOSE

The project aims to create an application for the hikers to identify rare species of birds, flowers, mammals by giving a picture taken by them. Field naturalists can only use this web app from anywhere to identify the birds, flowers, mammals and other species they see on their hikes, canoe trips and other excursions.We use artificial neural network to train these image and build a deep learning model.In this project, we are creating a web application which uses a deep learning model, trained on different species of birds, flowers andmammals and get the prediction of the bird when an image is been given.

CHAPTER - 2
LITERATURE SURVEY

2.1 EXISTING PROBLEM

The Problem is to classify the type of species. The key relationship in this work is between field biologist and technologists, thus many of our activities will involves hybrid artistic and scientific examinations of the wildness surrounding us. For instance we may develop biological tools for studying nearby creatures, and then adapt these into artistic devices for continued explortation and sharing of this phenomena.

2.2 SURVEY WORK

2.2.1 UNGULATE DETECTION AND SPECIES CLASSIFICATION FROM CAMERA TRAP IMAGES USING RETINA NET AND FASTER R-CNN (2022) [Gholamreza Anbarjafari, Ilja Pavlovs, Kadir Aktas, Egils Avots, Jevgenijs Filipovs, AgrisBrauns, Gundega Done, Dainis Jakovels, Gholamreza Anbarjafari]

This paper presents a new datasetof wild ungulates which was collected in Latvia. It demonstrate two methods, which use RetinaNet and Faster R-CNN as backbones respectively, to detect the animals in the images. Faster RCNN–ResNet50 network and RetinaNet were trained for 34,850 iterations (10 epochs) on the training dataset with a batch size of 4, learning rate of 0.0001 andAdam optimizer for the weight update. The general structureof the detectorinvolves image embedding, object localization and classification. DNN consisting of convolutional layerswhich are used for the feature extraction from the input image. Usually, backbone networks which are pre- trained on a naturalimage dataset such as ImageNetare used. Common networks used as the backbone are ResNet50, VGG160, Inception-ResNetV2 and DarkNet-19. The neck network takes and processes inputs from the different layers of the backbone, harnessing advantages of data pattern distribution over different feature map scales by using FPN (Feature Pyramid Network). A feed-forward neuralnetwork which performs the classification or regression task.

2.2.2 CONVOLUTIONAL NETWORKBASED ANIMAL RECOGNITION USING YOLO AND DARKNET (2021) [B.Karthikeya Reddy,Shahana Bano, G.Greeshmanth Reddy, Rakesh Kommineni, P.YaswanthReddy]

This research work has developed a YOLOV3 model to identify the animal present in the image given by user. The algorithm used in YOLOV3 model is darknet, which has a pretrained dataset. Machine learning has been applied to image processing. The image of animal will be given as input, then it will display the name of the animal as output by using YOLOV3 model. The detection is done by using a pre-trained coco dataset from darknet. The image is broken into various lengths and widths based on the given input image. Here for the recognition of image, YOLOV3 model is using recognizer deep learning package. The overall performance of the model is based on the different training images and testing images of the dataset. The detection is done by using a pre-trained coco dataset from darknet.

2.2.3 RECOGNITION OF ENDEMIC BIRD SPECIES USING DEEP LEARNING MODELS (2021). [Yo-Ping Huang,Haobijam Basanta]

The objective of the paper is identifying the bird species from images.This study developed a transfer learning-based method using InceptionResNet-v2 to detect and classifybird species. To validate the reliability of the model, it adopted a technique that involves swapping misclassified data between training and validation datasets. The swapped data are retrained until the most suitable result is obtained. Additionally, fivefold cross-validation was performed to verify the predictive performance of the model. The proposed model was tested using 760 images of birds belonging to 29 species that are endemicto Taiwan. The model has achievedan accuracy of 98.39% in the classification of 29 endemic bird species. The model achieved a precision, recall, and F1-score of 98.49%, 97.50%, and 97.90%, respectively, in classifying bird species endemicto Taiwan.

2.2.4 THE ANALYSIS OF PLANTS IMAGE RECOGNITION BASED ON DEEP LEARNING AND ARTIFICIAL NEURAL NETWORK(2020).[Jiang Huixian]

This paper aims to identify and classify the plant using the leaves of the plant. The approach is to extract plant leaf features and identify plant species based on

image analysis. The plant leaf images are segmented and the feature extraction algorithm is used to extract leaf shape and texture features from leaf sample images. An artificial neural network classification method based on backpropagation error algorithm (BP algorithm) is proposed to recognize plant leaves. This paper studies the existing plant image location and recognition technology, and introduces deep learning theory. After that, the high dimensional expression of image features by artificial neural network in deep learning theory is analyzed. The existing ANN model is improved and some new techniques and methods are introduced to construct a new ANN model. The model unifies the processes of image segmentation, target featureextraction and target classification

2.2.5 PLANT SPECIES RECOGNITION USING MORPHOLOGICAL FEATURES AND ADAPTIVE BOOSTING METHODOLOGY (2019). [Munish Kumar, Surbhi Gupta,Xiao-Zhi Gao and Amitoj Singh]

The paper uses a novel plant species classifier that recognizes the plant speciesin the image. Out of many features, leaf shape is a conspicuous element that most algorithms rely on to perceive and describe a plant. The system extracts the morphological features of the plant leaf and classifies using Multilayer Perceptron and other classification algorithm along with AdaBoost methodology. Different classifiers, i.e., KNN, Decision Tree and Multilayer perceptron are employed to test the accuracy of the algorithm.The authors have observed that the maximum precision rate of 95.42% has been achieved for 32 kinds of plant leaves and the proposed system has performed better than the existingtechniques for plant leaf recognition.

2.2.6 BIRD IMAGE RETRIEVAL AND RECOGNITION USING A DEEP LEARNING PLATFORM (2019). [Yo-Ping Huang, HaobijamBasanta]

The authors have developed a deep learning platform that helps users recognize various species of birds endemicto Taiwan. A mobile application named the Internetof Birds (IoB) is developed that recognizes 27 species of birds. The deep learning model for bird image classification using the CNN framework is described. Bird images were learned by a convolutional neural network (CNN) to localize prominent features in the images. The model established and generated a bounded region of interest to refine the shapes and colors of the object granularities and subsequently balanced the distribution of birds. Then, a skip connection method was used to linearly combine the outputs of the previous and current layers to improve feature extraction.

Then it applied the softmax function to obtain a probability distribution of bird features. The platform uses cloud based deep learning for image processing to identify bird species from digital images. The proposed system could detect and differentiate uploaded images with an overall accuracy of 98.70%.

2.2.7 AN EFFICIENT FRAMEWORK FOR ANIMAL BREEDS CLASSIFICATION USING SEMI-SUPERVISED LEARNINGAND MULTI- PART CONVOLUTIONAL NEURAL NETWORK (MP-CNN) (2019).[S. Divya Meena, L. Agilandeeswari]

The paper focus on classifying 27 classes of animals with 35,992 trainingimages. The proposed model classifies the animals on both generic and fine-grained level. It has built a semi- supervised learning based Multi-part Convolutional Neural Network (MP-CNN) with a hybrid feature extraction framework of Fisher Vector based Stacked Autoencoder. With Semi-supervised learning based pseudo-labels, the modelclassifies new classes of unlabeled images too. Hellinger Kernel classifier method has been modified and used to re-train the misclassified classes of animals which further enhance the accuracy. Semisupervised learning based pseudo-labels, the model classifies new classes of unlabeled images too. The testing accuracy increases as the models get trained. The experimental resultsshows that the overall accuracy is 99.6%.

2.3 PROBLEM STATEMENT DEFINITION

Problem Statement	I am (customer)	I'm trying to	but	Because	Which make me feel
PS-1	Reaserches	Scan the species to ideentify the behaviour	Unable to get the clear image	It contains low pixel value	upset
PS-2	Student	Explore the species	Unable to predict	It is poisonous or danger	panic
PS-3	Tourist	Capture the image	It shows data not found	More details to be updated	Anoxious
PS-4	public	Scan either flora and	It cant support	Both we separate	Frustrated

		fauna in same time		and consume large amount of time to scan	

CHAPTER -3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

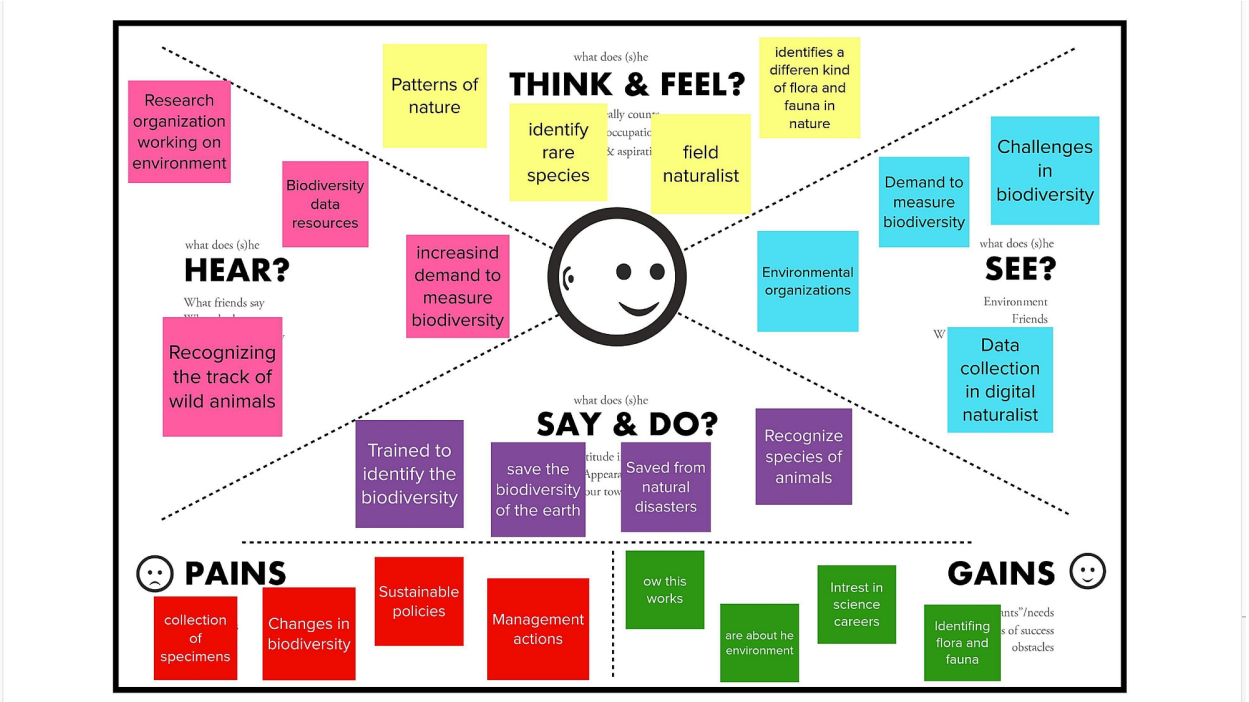


Fig 3.1 Empathy Map canvas

3.2 BRAINSTORMING AND IDEA PRIORITIZATION

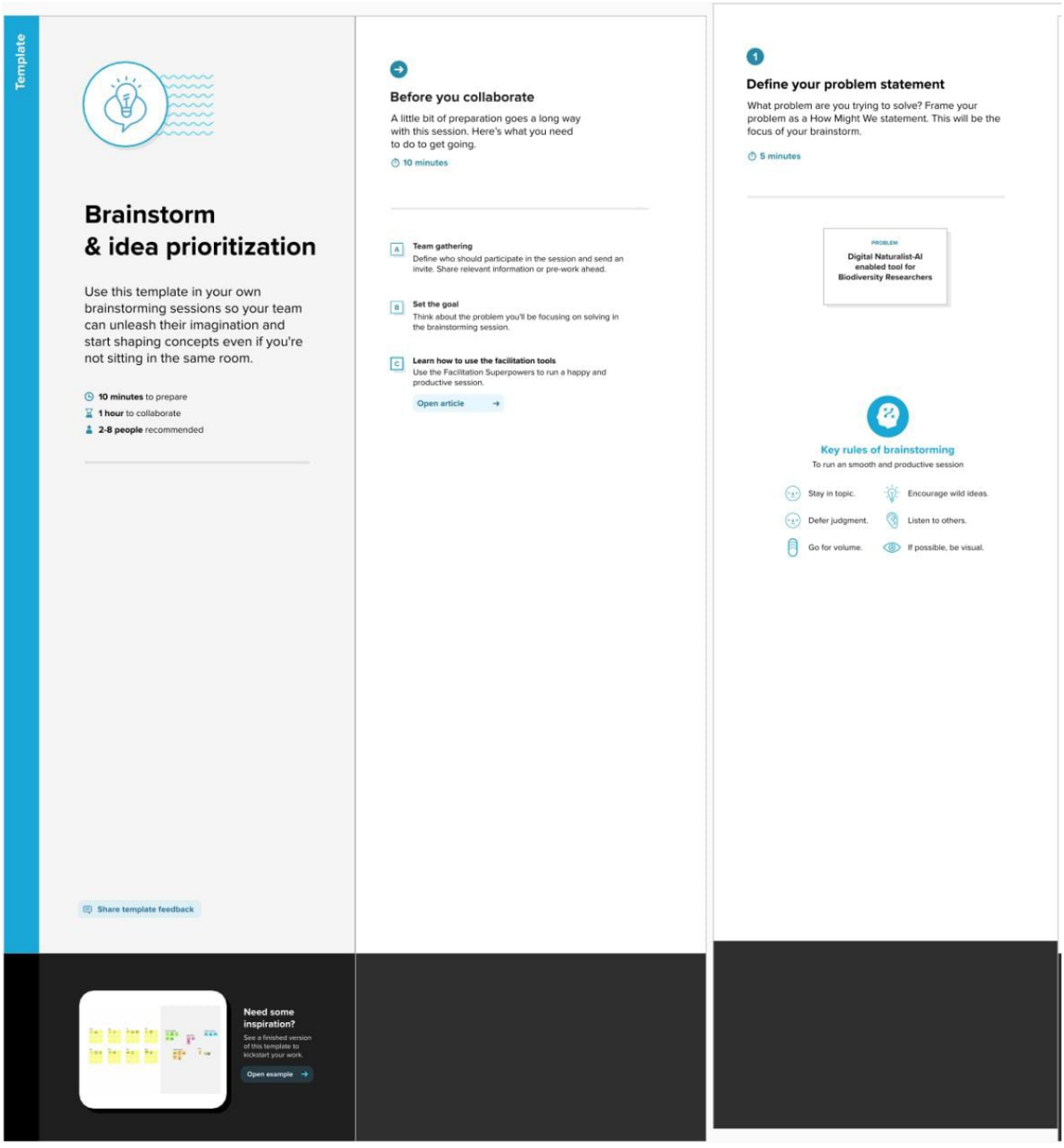


Fig 3.2 (A) Brainstorming and Idea Prioritization

Fig 3.2 (B) Brainstorming and Idea Prioritization

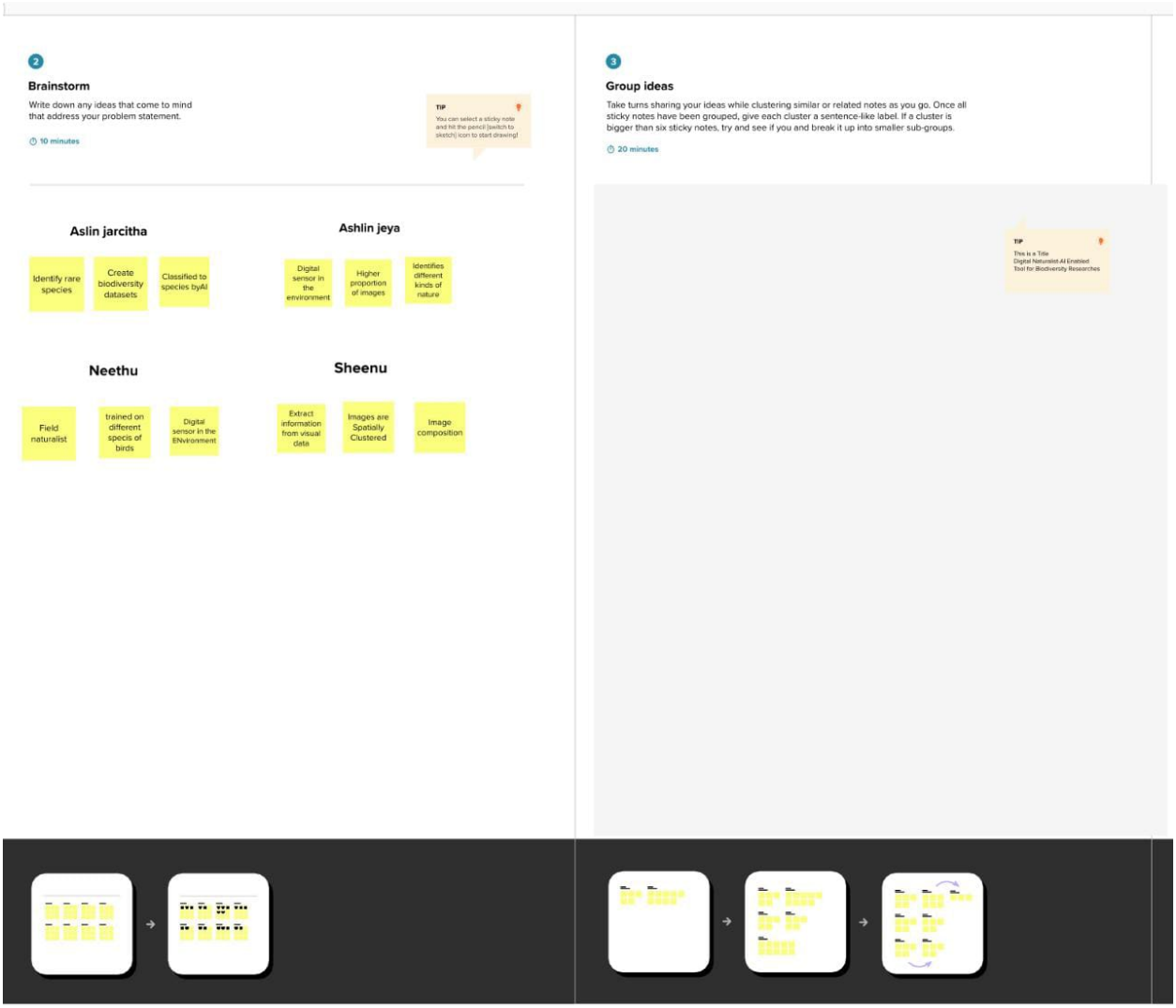


Fig 3.2 (C) Brainstorming and Idea Prioritization

3.3 PROPOSED SOLUTION

S.NO	Parameter	Description
1	Problem Statement (Problem to be solved)	To identify a species in a forest or in any other place, we need to carry a heavy book or seek a professional.
2	Idea / Solution description	A Web Application that is trained with CNN using deep

		learning model on different species can replace such big books.
3	Novelty / Uniqueness	The model can identify different species of plants, birds and animals.
4	Social Impact / Customer Satisfaction	Customer can identify the type of species faster and easier without searching in books page by page.
5	Business Model (Revenue Model)	The model can differentiate the species at a faster rate with better accuracy.
6	Scalability of the Solution	The web application apart from researchers can also be used by students and common people .

3.4 PROBLEM SOLUTION FIT

Define CS, fit CC

1. CUSTOMER SEGMENT(S) CS

1. Experience professionals and Inexperienced people who are willing to learn about bio diversity.
2. People who go for hikes or trips to the forest areas and mountains.
3. Amateurs or Students or people who like to learn more about the biodiversity.

6. CUSTOMER CONSTRAINTS CC

1. No knowledge about bio diversity.
2. Cannot remember everything.
3. Not able to identify the plants and animals

5. AVAILABLE SOLUTIONS AS

1. Field naturalists always carry a guidebook around everywhere or seeks help from experienced Ornithologist.
2. Get help from experienced people.
3. Internet and other apps

Explore AS, differentiate

Focus on J&P, tap into BE,

2. JOBS-TO-BE-DONE / PROBLEMS J&P

1. Fear of misidentification.
2. Need to know about at least the basics.
3. No knowledge or experience about bio diversity as the user is just starting to learn which can lead to confusion

9. PROBLEM ROOT CAUSE RC

1. Need to depend on experts like Ornitologists, Zoolagists, Botanist.
2. Users may not be a naturalist or just a student who just started to learn so they may not know any information.
3. Too much data cannot be stored by any human or they may forget or other due to any other problems like age.

7. BEHAVIOUR BE

1. Carry guide books or other notes to identify species.
2. Get help from experienced professionals
3. Try to remember the species based on its feature.
4. Plant identifier.
5. Animal identifier

Focus on J&P, tap into BE,

Identify strong TR&EM

3. TRIGGERS TR

They hear about new app with best features by their friend or colleagues, or read about appin news, or search the internet on their own.

4. EMOTIONS: BEFORE / AFTER EM

1. Before: Feel very sad to carry book always. They may hesitate to task help from experts. Sometime feels shame to ask help from experts

After: Feels happy no need carry heavy books. Feel proud because no need to seek help from experts.

10. YOUR SOLUTION SL

1. All information should be available in on application.
2. Display Botanical names .
3. Display alert messages for plants/animals using different colors .
4. Small description about them .
5. Rarities of the species

8.CHANNELS of BEHAVIOUR CH

ONLINE

1. All features are accessible during online.
2. Search using the internet about the species

OFFLINE

1. Get help from friends or professionals.
2. Guidebook or they even take their own notes

Extract online & offline CH of BE

CHAPTER-4

REQUIREMENTS ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Login	Enter the valid username and password
FR-4	capturing	Capturing the species image
FR-5	Uploading	Captured image can be upload in the application
FR-6	Processing and displaying	It process and shows the result about the species details

4.2 NON-FUNCTIONAL REQUIREMENTS

Following are the non-functional requirements of the proposed solution

FR No.	Non- functional Requirements	Description
NFR-1	Usability	It helps user to get information about the species and also user can access our site without any prior knowledge.
NFR-2	Scalability	It generate the OTP whether

		the user given phone number or email are valid
NFR-3	Reliability	Different and rare species information are availability in our sites.
NFR-4	Performance	Speed Response Bandwidth constraints
NFR-5	Availability	Focuses on the user's expectation and experience.
NFR-6	Scalability	Handle current and future loads It works more efficiently.

CHAPTER-5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

Data Flow Diagrams:

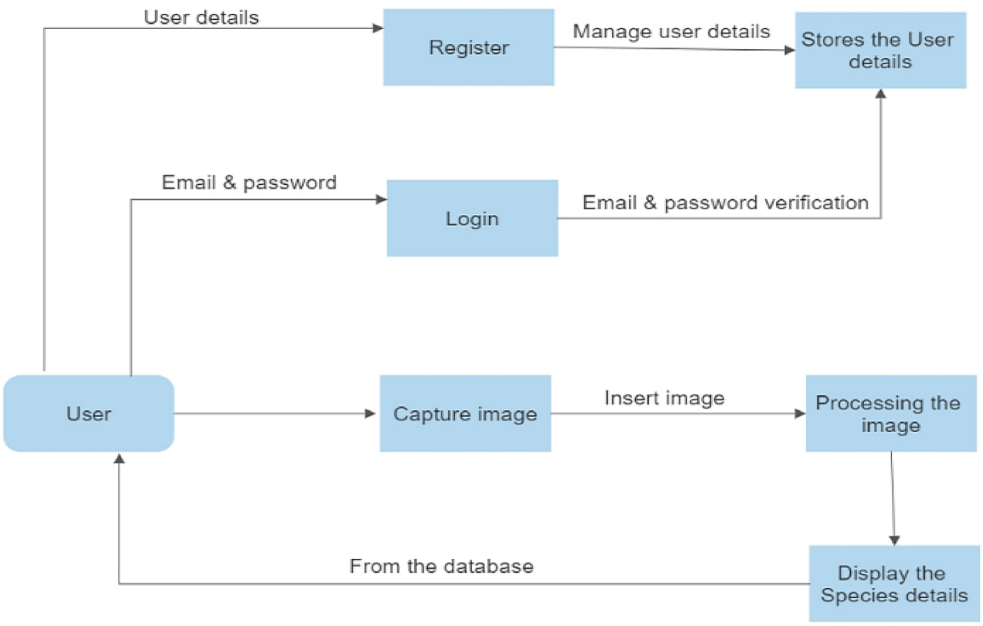


Fig 5.5 Data Flow Diagram

5.2 SOLUTION ARCHITECTURE

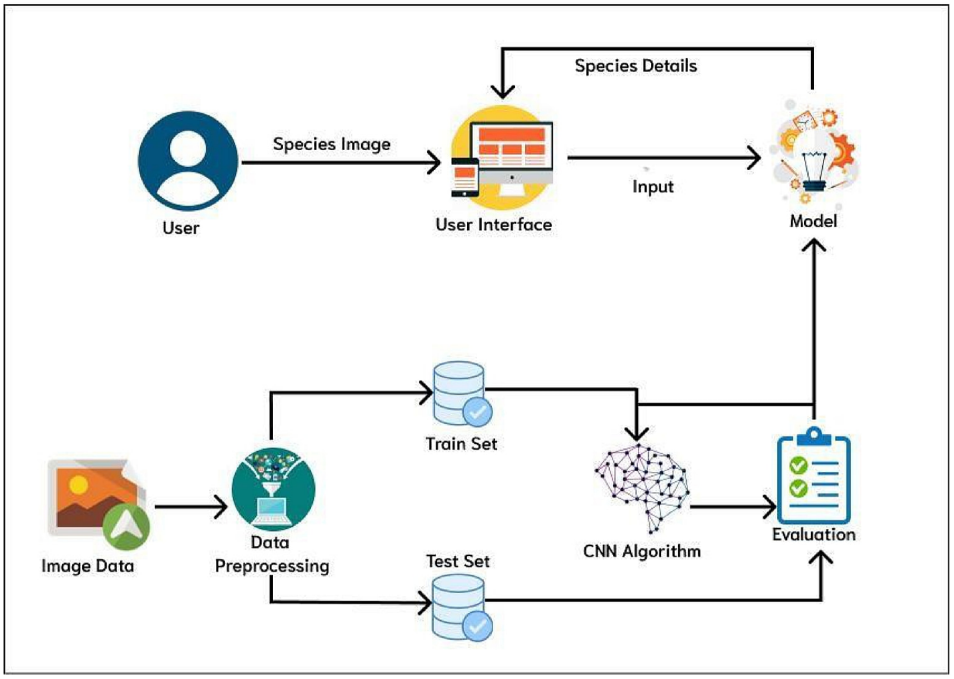


Fig 5.2 Solution Architecture

TECHNICAL ARCHITECTURE

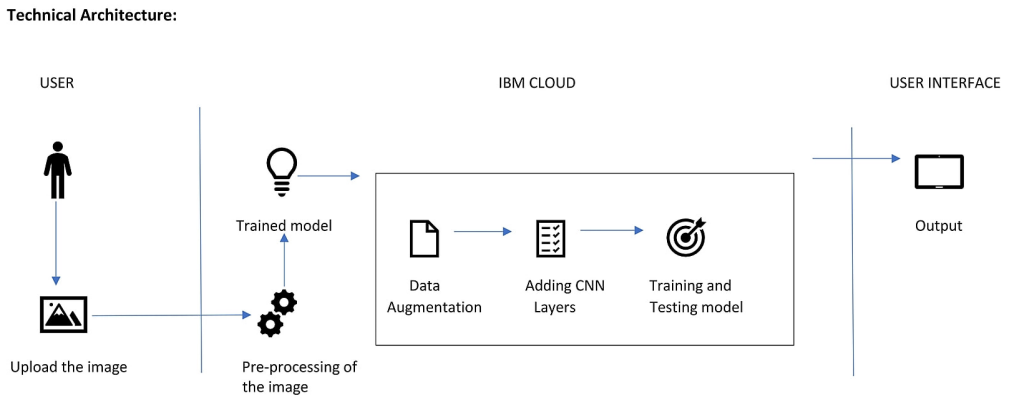


Fig 5.2 Technology Architecture

5.4 USER STORIES

User type	Functional Requirement (Epic)	User Story Number	UserStory/ Task	Acceptance criteria	Priority	Release
User	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account/ dashboard	High	Sprint-1
	Confirmati	USN-2	As a user, I	I can	High	Sprint-1

	on		will receive confirmation email once I have registered for the application	receive confirmation email&click confirm		
	Login	USN-3	As a user, I can log into the application by entering Gmail and password	I can access the dashboard with Gmail account.	Low	Sprint-2
	Capturing	USN-4	As a user,I can capture the imageof the species.	I can storethe photo in the devices.	High	Sprint-1
	Upload	USN-5	As a user, I can upload of the imageof the species.	The image fed into the web application.	High	Sprint-1
Admin	Processing and Display	USN-6	As a Admin, I can display thedetails of the species.	I can view the details ofthe species.	High	Sprint-2

CHAPTER-6

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint	Functional Requirement (Epic)	User Story Numb er	UserStory / Task	Story Points	Priority	Team Members
Sprint-1	Registrati on	USN-1	As a User, I can register for the application by entering my email,pass wo rd and confirming by password.	2	High	Aslin jarcitha.p
Sprint-1		USN-2	As a user,I will receive confirmati on email oncel have registered for the application.	2	low	Sheenu
Sprint-1	Login	USN-3	As a user,I can log into the application by entering email & password		Medium	Neethu
Sprint-1		USN-4	As a user,I can uploadthe image to	3	High	Ashlin jeya

			identify thespecies.			
Sprint-1	Dataset collection	USN-5	Datasets are collected to train the model.	2	High	Aslin jarcitha
Sprint-2	Data preprocessing	USN-6	The data is loaded andPreprocessed to trainthe model.	4	high	Ashlin jeya
Sprint-2	Build and Train the model	USN-7	The modelis trained using Training dataset.	8	high	Neethu
Sprint-2	Evaluate the model	USN-8	The model is evaluated.	6	high	sheenu
Sprint-3 .	Create Application	USN-9	Application is builtusing Python Flask	6	medium	Aslin jarcitha

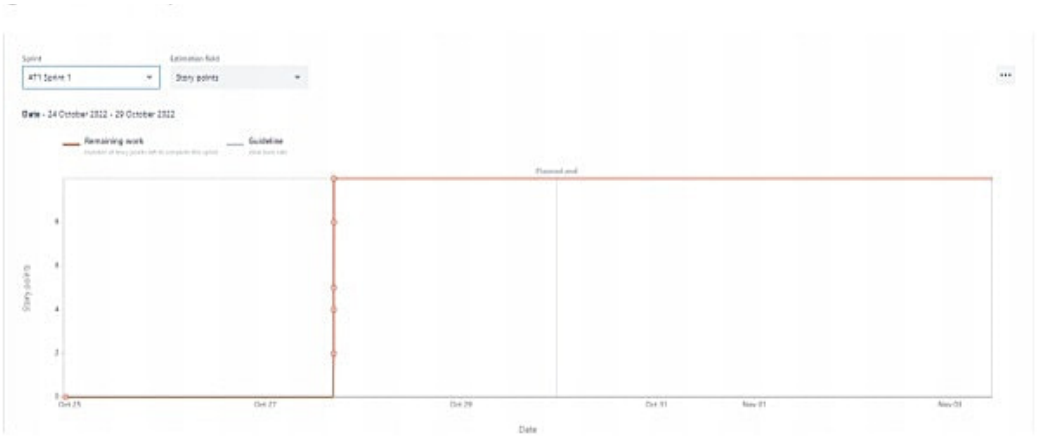
6.2 SPRINT DELIVERY SCHEDULE

Sprint	**Total Story Points**	**Duration**	**Sprint Start Date**	**Sprint End Date (Planned)**	**Story Points Completed (as on Planned End Date)**	**Sprint Release Date (Actual)**
Sprint-1		6 Days				

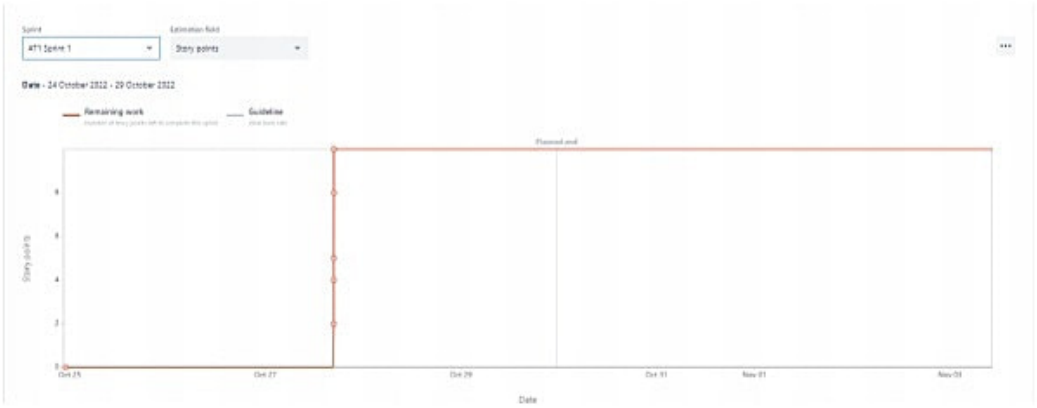
	10		19 nov 2022	19 nov 2022	10	20 nov 2022
Sprint-2	18	6 Days	21 nov 2022	21 nov 2022	18	21 nov 2022
Sprint-3	14	6 Days	21 nov 2022	21 nov 2022	14	22 nov 2022
Sprint-4	8	6 Days	22 nov 2022	22 nov 2022	8	22 nov 2022

6.3 REPORT FROM JIRA

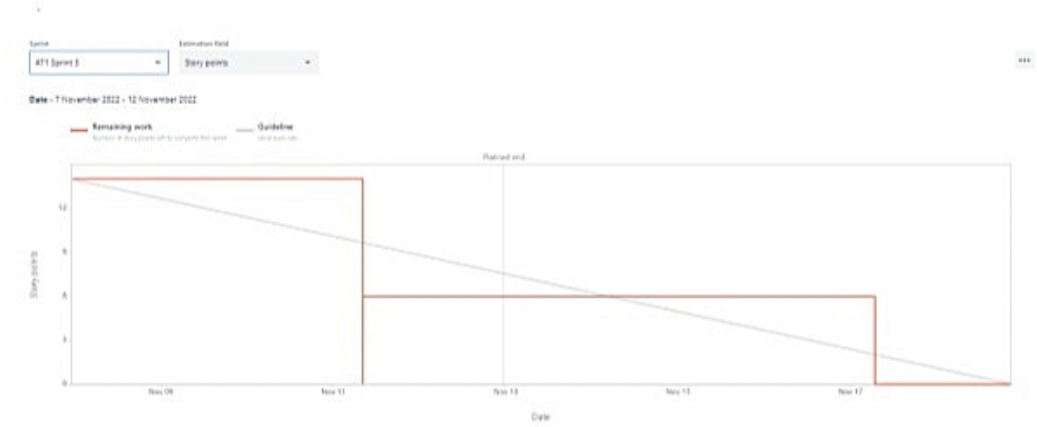
SPRINT 1:



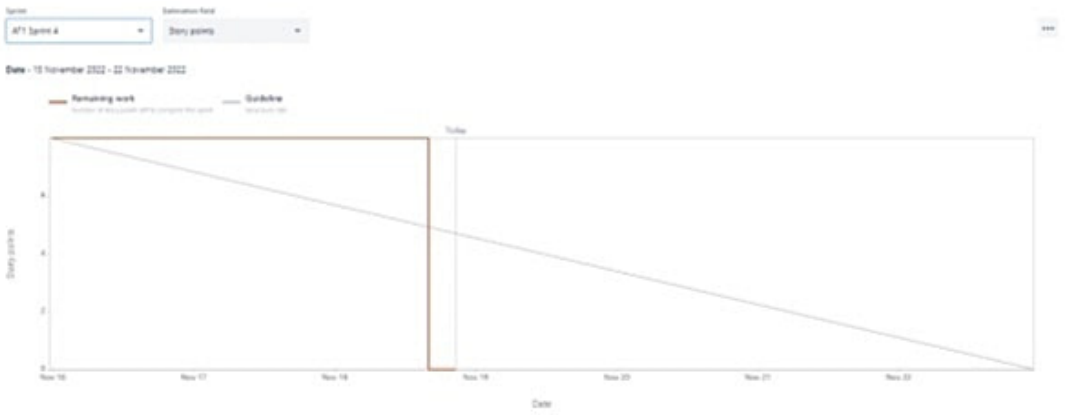
SPRINT 2 :



SPRINT 3 :



SPRINT 4:



CHAPTER - 7

CODING & SOLUTIONING

7.1 FEATURE 1

The web application accepts an image as input and passes it to the CNN model . This model is built locally and deployed into python flask.

```
pred = np.argmax(loaded_model.predict(x), axis=-1)
```

7.2 FEATURE 2

The image passed by the app is classified by the CNN model. The name of the species is passed from the model to the application.

```
pred = np.argmax(loaded_model.predict(x), axis=-1)
```

CHAPTER-8

TESTING

8.1 TEST CASES

Test case ID	Compo nent	Test Scenario	Steps To Execute	Test Data	Expected Result	Actual Result	Status
LoginPage_TC_01	Home page	Verify user is able to see the Login/Sign in page when user clicked on login button	1.Enter URL 2.Click on Explore now/log in button 3.Verify login/Sign in page displayed or not		Login/Sign in page should display	Working as expected	Pass
LoginPage_TC_02	Login page	Verify the login elements Login/Sign in appear	1.Enter URL 2. Click on Login button 3.Verify login/Sign in elements : a. email text box b. password text box c. Login button d. Sign up link for new user account.		Application should show below UI elements: a. email text box b. password text box c. Login button d. Sign up link for new user account.	Working as expected	Pass

LoginPage_TC_03	Login Page	Verify user is able to log into application with Valid credentials	1.Enter URL 2. Click on Login button 3.Enter Valid username/email in Email text box 4.Enter valid password in password text box 5.Click on login button	Username:jarcithaaslin@gmail.com password:aslin437	User should navigate to upload page	Working as expected	Pass
LoginPage_TC_04	Login Page	Verify user is able to log into application with Invalid credentials	1.Enter URL 2. Click on Login button 3.Enter valid username/email in Email text box 4.Enter Invalid password in password text box 5.Click on login button	Username:jarcithaaslin2gmail.com password:aslin437	Application should show 'Invalid details' validation message	Working as expected	Pass

LoginPage_TC_05	Upload Page	Verify user is able to upload image file	1.Click choose file 2.Select image from local directory	Flower.png	The image should be uploaded	Working as expected	Pass
LoginPage_TC_06	Upload Page	Verify user is able to view the species name	1.Click predict button	Flower.png	Flower name should be shown	Working as expected	Pass
LoginPage_TC_07	Upload page	Verify user is able to logout	1.Click logout button		User should navigate to upload page	Working as expected	pass

8.2 USER ACCEPTANCE TESTING

8.2.1. PURPOSE OF DOCUMENT

The purpose of this document is to briefly explain the test coverage and open issuesof the Digital naturalist AI tool based on biodiversity resarchers project at the time of the release to User Acceptance Testing (UAT).

8.2.2. DEFECT ANALYSIS

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Sub total
By Design	9	5	3	2	19
Duplicate	0	1	2	1	4
External	3	4	1	2	10
Fixed	10	3	5	21	39
Not	0	0	0	1	1

Reproduced					
Skipped	1	1	0	0	2
Won't Fix	0	3	3	2	8
Totals	23	17	14	29	83

8.2.3. TEST CASE ANALYSIS

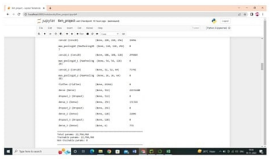
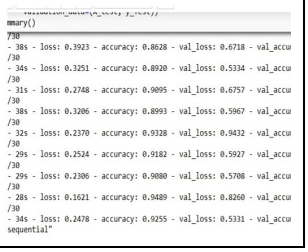
Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	50	0	1	50
Security	3	0	0	3
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

CHAPTER - 9

RESULT

9.1 PERFORMANCE METRICS

Model Performance Testing:

S.No.	Parameter	Values	Screenshot
1.	Model Summary	Total params:22,704,9 66 Trainable params:22,704,9 66 Non-Trainable:0	
2.	Accuracy	Training Accuracy - 92.55 Validation Accuracy - 78.69	

CHAPTER - 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES

Main advantage in our application is to provides three different species in one web application using the deep learning concepts.It does not require any special hardware because it can be implemented with low-cost devices such as cameras. An understanding of what species are and how to identify them is critical, both for biologists and for the general public. Biological diversity is being lost as species go extinct, and it is only by understanding species.

DISADVANTAGES

The main disadvantage of our model is that the accuracy rate is low when the input image is not clear. Another disadvantage of this system is that it consumes time to and the system may not be able to recognize some numbers, such as possible.

CHAPTER - 11

CONCLUSION

Field naturalists can only use this web app from anywhare to identify the birds,flowers,mammals and other species they see on their hikes,canoe trips and other excursions.In this project, we are creating a web application which uses a deep learning model, trained on different species of birds,flowers and mammals.There is great diversity among naturalists, but some common ground too. All naturalism begin with an admiring attitude towards science and its achievements. In many cases this admiring attitude is combined with a contempt or distrust for the way that philosophy has been or is conducted. This combination of views has a long history.Many of the advocates of first philosophy,Descartes,kant and Carnap, shared the same admiration of science or nascent science and distrust of philosophy.Descartes, for example. uses scepticism as a device to sweep away the old Aristotelian foundations of knowledge, so that he can build an entirely new philisophy that makes room for the new mathematical science.

CHAPTER - 12

FUTURE SCOPE

Essentially, the proposed guidelines treat statistical comparison of ML based quality estimators as a multi-dimentional problem. Accordingly, we seek to assess the predictors more holistically in terms of thier local performance on specific test conditions,their learning ability and the magnitude of treatment affect(to quantify the practical significance of the observed differences). In constract, the current approach tends to reduce this task to binary and global statistical decision making and does not reveal systematic weakness of the predicators. In order to provide a tool for pratical use, software implementing the proposed guidelines is made publicly available.

CHAPTER - 13

APPENDIX

13.1 SOURCE CODE

```
import
 os
 import numpy as np
from keras.models import load_model
from keras.preprocessing import image
 import tensorflow as tf
 from flask import Flask, render_template, request
 from werkzeug.utils import secure_filename
 from keras.models import model_from_json
 from PIL import Image

 app = Flask(__name__)
 json_file = open('final_model.json', 'r')
 loaded_model_json = json_file.read()
 json_file.close()
 loaded_model = model_from_json(loaded_model_json)
loaded_model.load_weights("final_model.h5")
# loaded_model=load_model('uploads/final_model.h5')
 @app.route('/')
def index():
 return render_template("home.html")
 @app.route('/login')
def index1():
return render_template("login.html")
@app.route('/register')
def index2():
return render_template("register.html")
 @app.route('/upload')
 def index3():
 return render_template("upload.html")
 @app.route('/predict', methods=['GET', 'POST'])
 def Upload():
 if request.method == 'POST':
```

```
 f = request.files['image']
 basepath = os.path.dirname(__file__)
 file_path = os.path.join(basepath, '', secure_filename(f.filename))
 f.save(file_path)
 img = image.load_img(file_path, target_size=(224, 224))
 x = image.img_to_array(img)
 x = np.expand_dims(x, axis=0)
pred = np.argmax(loaded_model.predict(x), axis=-1)
 op = ['Great Indian Bustard Bird', 'Spoon Billed Sandpiper Bird', 'Corpse Flower', 'Lady Slipper
Orchid Flower',
 'Pangolin Mammal', 'Senenca White Deer Mammal']
text = op[pred[0]]
 return render_template('upload.html',value=text)
 if __name__ == '__main__':
 app.run(host='0.0.0.0',port=8000,debug=True)
```

13.2 GITHUB & PROJECT DEMO LINK

Github link :https://github.com/IBM-EPBL/IBM-Project-40061-1660622556

Project Demo :
https://drive.google.com/file/d/1uylQbp0LY_GeopuR3KfzKXUHzz5pQ145/view?usp=drivesdk

CHAPTER - 14

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