PLANTRECOG- An Approach of Automatic Plant Species Recognition by Leaf Using Convolution Neural Network (CNN)

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Abstract

Deep learning is quite popular in the field of image processing. consequently, it is mostly used for identification and recognizing different subject and object in the images. Image recognition is the most innovative and revolutionary field of artificial intelligence which deals with pixels pattern to map their object by using pooling or edge detection and sketching methods. In this filed one of the most problem that is commonly facing by any botanist. Because they did not recognize any plant species because lack of proper identification of each and every species of plant and it is quite vast diversity in the context of Nepal. In this work, we were finding out how we going to resolve plant identification and detection problem by using the power of convolutional neural network (CNN) by using Plant@Nets Datasets 2 were 3200 images with 53 different classes. We will also find out what are the accurate and suitable steps to develop PlantRecog Application by using Convolutional neural network. Secondly, the researcher would like to include the process and mechanism of PlantRecog application development process and how the process 50 x 50 greyscale images to identify any plant species by using Convolutional neural network (CNN). This problem is directly belonging to the classification of Machine Learning (ML). we also implemented the best suitable waterfall software development methodology to carries out the complete work of PlantRecog applications. we give complete information about which kinds of hardware and software required for the development and deployment of PlantRecog Applications. we used primary and most popular libraries such as TensorFlow, Keras, Scikit learn and pillow to process the image data and allows algorithms to learn from them. The overall process of development carries out by using the Python programming language.

Keywords: Image Recognition, Plant Identification, Machine learning (ML), Deep Learning (DL), Neural Networks (NN), Convolutional neural network (CNN), Greyscale

1 INTRODUCTION

This project is all about the automatic plant species recognition by leaf using convolution neural network that can help us to automatically recognize unidentifiable species of plant by leaf textual and shape features. Convolution neural network is algorithms which are extensible use in image identification and recognition by consuming the power of the artificial neural network. Nowadays most of the botanist scientist facing problem to take a sample of rare and most important plant species for their herbal and medicine research by using this application will help to reduce their tedious time-consuming task. Nowadays the computer becomes more powerful every day with the new technology innovation and growth as similar in the context of Computer vision. Computer vision is one of the most powerful branches of artificial intelligence which is identified recognized and disguised between more than two objects. Today most of the powerful algorithms support to recognized with their optimum accuracy. Among them, one is a Convolution Neural network.

1.1 Background to the Project

A convolutional neural network (CNN) is an algorithms of deep learning application which is fully capable to recognized and identify any kinds of images. They basically work on to take any size input images with their weight and biases. each layer can learn from images shape and texture pattern to help computer to recognized images. (Saha, 2018). Which is purely inspired on Human visual cortex working mechanism. This biological visual cortex is especially as receptive field of

image recognition (Sharma, 2017). Every artificial neuron itself as future extractor to identify hidden pattern of object exists in images and predict images classes with accuracy.

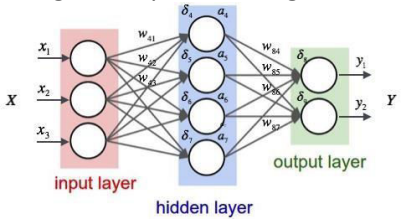

Figure 1: Neural Networks (Valkov, 2017)

1.2 Problem Context

Plant Species identification in Nepal is very tough task because Nepal is rich in plant-diversity. Most of the plant which is mostly used in medical research to cure the different diseases. The major concern about work dedicated to resolving this kind of problem in a context of Nepal. And this problem nothing new. In currently most of botany expert and researcher to take problems to collect sample of plant and its difficult and time-consuming task ever for the botanist experts (Thi-Lan Le, 2015).

System is capable for resolve problem currently facing botanist experts in daily life. It's also based on image recognition so it will interpret images as visual context like a human and gives instant results according to match according to train by previous plant leaf data. Allopathic medicine has a rich history with a few Ayurveda leaf's which can't be recognized by a human being. It's clearly shown its difficult task to remember each plant species for every human (Anant Bhardwaj, 2013).

This word clearly says us, any person who has a lack of knowledge about plant species and their leaf shapes. it's like a difficult and impossible task to take a sample of the plant so the author says us is a huge problem to resolve Identifying a plant can be tricky task even for experience botanists, considering the huge number of species existing in the earth (Soflene Mouine, 2012).

There are no surprising things in context of Nepal. most of botanists faced problem for identification of plant species because there are 6,391 plant species available in Nepal and it is much more tedious task to collect sample of images by botanist experts and researcher (NATURALLYNEPAL, 2006)

1.3 Rationale

According to the problems stated above, a plant recognition by leaf "PlantRecog" will be a Convolution neural network-based model to easily deployable in a standalone web application which allows botanist researcher to automatically recognized plant by their leaf features. this application will be able to reduce and correctly classified different kinds of plant species. the main advantage of this application is a reduced time-consuming task like plant identification available in Nepal. For the project, we will collect several plant species samples that will be helpful for the further researcher to perform their analytics to develop and improve this system Image Recognition by leaf feature is new immerging technology for computer vision. it creates a huge possibility of developing such an effective artificial intelligence application which evolves new generation technology. adjusting plant species images according to neural networks algorithms weight and biases. The system will be using preprocessing techniques to validate and adjusting images data into expected input size of the model. PlantRecog model convolution and the hidden layer will perform filter manipulation to the recognized hidden pattern of matrix data.

For the case of the pre-train model like VGG16 and MobileNet it will be great to implement for highest accuracy output of the model if my own model does not produce great accuracy. As plant species recognition it will require some modification in a network to tune hyperparameter to predict optimal level of predictions. Each model is required their own different input shape of images to perform algorithms.

This system can use for botanist experts and individual researcher. as outcomes of these projects belong to two kinds of benefits:

1.4 Tangible Benefits

- This application is going tribute of botanist experts to reduce their time-consuming task.
- Reduce human resources to open plant leaf identification dictionary.
- "PlantRecog" Convolution neural network model able to show details about plant where it belongs.
- Do computerized of technological contribution of the plant and save the life.
- Easily access everywhere by web application.
- Evolve medicine research to cure diseases.

1.5 Intangible Benefits

- Something will contributable for botanist experts to save the life of nature as saves us.
- earn recommend trust and believe of this botanist Expert by this application to promote positive vibes of work.
- Able to collect feedback of botanist to further improve this application.
- Helps to Grown technical skills to develop such kinds of system in future.
- Way to Contribute Artificial intelligent research to evolve our technology.

1.6 Target Users

This System will be using various categories of peoples which directly and indirectly involved in plant research, medicine cure research group and the individual student. The age group we are targets as 18 to 65 years for researcher, taxonomies, student and botanist experts. The first category of the target user is Botanist Expert, Taxonomies which is directly linked to plant and medicine research to find a cure for diseases. They used this application to find specific types of plant to do the experiment. The second category is a student which is used for doing their data-collection of plant species and do perform analytic, finding of plant species in Nepal. Third we technical person to understand how this system is working based on algorithms and business rules of the computer science and real-world examples of Image recognition. The system usability is also for upgradable and easily understand the reverse-engineering process of these applications.

1.7 Aim

The project aims to provide image recognition model which is easily deployable in the web application to resolve existing plant species identification and recognition problem facing our botanists' experts and individual researcher to reduce their sample error of plant identification.

1.8 Objectives

- To study and analyze various plant species.
- To extract distinguished features of different plant species
- To develop leaf classifier model as based on Convolution Neural Network
- Used such Pre-train Model to train leaf dataset if my own model not give highest accuracy.
- provide Web application implementable model to recognized different plant species by their leaf feature.
- Model will be able to Integrate Web Application.

1.9 Deliverables - Functionality of the proposed system

According to our "PlantRecog" plants recognition model which is smart and intelligence system of plant species recognition by leaf among 50 kinds of species able to detect. As the project core functions can correctly classify 50 Species of plant available in Nepal. Our "PlantRecog" model is able to predict plant scientifically. As results, the web application will give outputs as the scientific

name of the plant species. Apart from the system if time available, we will also add or make sure to capable for switch VGG16 pre-train model which can be modified according to our datasets and able to predict plant species name by leaf. It can be surely reducing the time-consuming task of the botanist expert and individual researcher. Let go for functionalities of the "PlantRecog" image recognition model as listed below.

The feature of this application will be deliverables as shown below

1. It clearly identified 53 species of plant by given leaf image
2. To create responsible web application which can run laptop, tablets, and mobile devices
3. This model will be approximate 80% accurate minimum by using our own model or used such transfer learning of pre-train model.
4. It can also show all the details about each 53 to 100 species of plant with images.

1.10 Nature of Challenges

Automatic Plant Species recognition by the leaf is the biggest challenge is our lack of knowledge because of everything possible in the project to after accomplishment of the knowledge and skills. Secondly, we will be understood which kinds of the plant is mostly required in botanist expert and cannot be recognizable. Later we will collect those sample as well rare plant sample to train the major image recognition algorithm Convolutional neural network (CNN). Thirdly, the major challenge occurs how to tune hyper-parameters to increase accuracy invalidate and test datasets. After resolving these challenges, again, comes. Finally, major challenges arrived how to make our model to easily deployable into a web application which can easily surf million of the users. How we can make this system efficiently and effectively run on a web browser and its optimizations. After overcomes all challenges we achieve the main goal.

2 LITERATURE REVIEW

2.1 Plant Species Recognition History

At today most of the research conduct for save plant for save environment. Such literature for collects record about plant species available on earth and how we can save it. As important factor is most of the plant identify by their leaf, so the leaf is major classifier of every plant to recognized for a specific purpose. In the initial stage, it's very difficult to develop such a system based on image recognition powered by deep convolution neural network as today. It's not going developed this technology for only botanist researcher's problem its more than records such plant kinds for future research. March 2018 Species distribution modeling based on the automated identification of citizen observations was done again other researcher as their sample data was 11000 species using the Caffe framework the linear classification layer was replaced by new and one aimed at classifying the new classes. at the first time, it was initialized random weights and learning rate was multiplied by 10 for this layer and the other layer was unchanged and initialize by ImageNet networks by their Weights by learned. This network was trained 332,000 plants species images of training sets. The batch size was 16 images every iteration. The image resolution was 224*224 pixels with the learning rate 0.0075 as output 70% accuracy. (Christophe Botella, 2018)

In Fourier descriptors and newly developed shape defining feature. This feature and attributes are given to Artificial neural network as the input vector. Datasets fit by FLAVIA and ICL, as reported accuracy for both datasets as train and test are 96% (Jianwei YANG, 2016).

After this research will continue Zalikha Zulkifli as purposed generalized regression Neural network for classification. The author compares Zernike moment invariant, legendre moment invariant and tehebichef moment invariant properties responsible for feature abstraction from leaf images. Zernike moment was doing a great work to combine with another scholar classifier of Abdul. Zernike moment invariant also added grey level co-occurrences metrics, geometric features, colors accuracy. 94.96 % accuracy obtained (Akshay A Patil, 2016).

Categorizing plant images at the variety level: Did you say fine-granted? Was done researcher for a fair examination of both classification methods, they do all images can be converted into

256 x 256 pixels as a standard resolution. they used the Fisher vector's methods for sampling step of 3 pixels and 5 different scales extracted. As their maximum accuracy was done through convolution neural network by CNN4 with ImageNet with Histogram equalization as top1 was 88.67%, top 2 was 98.93 and top 3 was 99.82 percent accuracy rates of the CiredRiceSeed datasets. The batch size was 32 and the gamma values were 0.9 the base learning rate was 0. 00001.CNN4 really did a good job in the context of an examination of natural images of ImageNet. Was accuracy level of 88.67%. (Julien Champ, 2016)

Advance tree species identification using multiple leaf parts images queries was done by previous author as their sample was 3070 images for 70 species and used the contour-based algorithm as accuracy rate was 39.32%. (Olfa Mzoughi, 2013).

Advance shape context for plant species identification using leaf image retrieval was done past researcher worked based on local and shape-based features. They represent the shape context models in the two ways like first for a different set of points are distinguished when computing the shape contexts like a voting sets and another is course arrangement of the shape are computing sets. Its part developed for where the shape contexts are computed. This experiment was enriched by introducing local features computed about computing points. In term of talk about the sample. leaf sample was 2349 and there are two sets of 3 sets of scenarios SC0, SC1, SC2 has been tested and computer set cardinality 50 and 400 the main results was Map (50 points) are std 0.45.the highest accuracy was sc2+std scans was 0.650 percent. (Sofience Mouine, 2012)

In 2011 Sabanci-Okan System in LifeCLEF 2015 Plant Identification Competition was done by as another researcher. they used algorithm CNN by PCANet and not require large datasets because they used principal components analysis to automatically learn the weights. Also used multistage filter banks a simple binary hashing to filter data and feature are pooled form block histograms. A multiclass linear support vector machine (LVM) trains the system. after training the system it was done plant datasets of LifeCLEF 2014 as well 2015. As inverse rank score was 0.153 as the inverse rank score for the observation-based task was 0.162 in context of LifeCLEF 2015 datasets. After testing was done in LifeCLEF 2014 datasets the inverse rank score was highest like 0.51. (Mostafa Mehdipour Ghazi, 2011)

Leaf recognition for plant classification using GLCM (Gray-Level Co-occurrence Metrix) and PCA (principal component analysis) methods done by author used algorithm were trained 390 leaves to classify 13 types of species with 65 new or deformed leaves images. The output was GLCM accuracy 78%, and accuracy of PCA is 98%. (ABDOLVAHAB EHSANIRAD, 2010).

Plant image retrieval using Color, shape and texture features research title was done researcher. the major concern about this research was they represented content-based image retrieval system for plant images, especially for house plant identification problem. A plant image contains a collection of overlapping leaves flower. Which makes great challenges to create a system. They introduce some texture matching technique and shape features. Then conduct segmentation as well feature extraction for plant region as do max-flow min-cut techniques. as they choose database was 380 pants images belong to 78 different plant species. The overall system was 55% accurate to retrieve top 15 images and 73% accuracy goes when a 132-image subset of well-segmented plant images are considered. (Hanife Kebapci, 2010) finally, journals combining interest points and edges for content-based image retrieval was done by Chinese researcher. In this research, they work for combine features to retrieve images containing specific objects, scenes or building there is nothing different than leaf identification and recognition. They categorized images as two parts like Harris-Laplace interest points described by the SIFT descriptor and edges was explained by edge color histogram. The first Harris –Laplace interest points were tested on the COIL-100 image database. Many objects in this database so simple that only less than ten interest points detected in one image. For each image there is views (view 0,30,60,90,120,150,180,210,240,270,300,330) included our database and another 60 views. The recognition rate 91.5% accuracy. The correct ratio was 59.5%. after later they conduct another test in ZuBuD database where containing 1005 images of 201 building in Zurich. the image resolution

was 640*480. according to the new indexing method HPAT (Hyper – Polyhedron with adaptive threshold). The accuracy rate was 91.3%. the training was 15 minutes. (Junqiu Wang and Hongbin Zha, 2005)

3 RESEARCH METHODS

Waterfall software development methodology is one of the oldest methodologies for software development. Waterfall methodology works on the linear and sequential software development approach. It is easier to understand and use. There are consists of five major phases as requirement gathering and analysis, system design, system implementation, system support, and maintenance. This method is selected for the system development.

3.1 Justification of chosen Research Method

"PlantRecog" is a web application. Initially, we fixed our scope and requirement of PlantRecog application. so, there is no chance to overcome new requirement and future scope need to develop. As based on the nature of the project we choose waterfall development methodology is the best fit for our project. There are no changes required for scope validation. We will only focus on the quality product rather than the speedy delivery of the product. In Quality prospective waterfall, the methodology is best suited for quality-oriented product development. It is straightforward nature so we can easily allocate and manage resources required for the development of "PlantRecog" Applications.

4 SYSTEM ARCHITECTURE

4.1 Introduction

Systems Architecture is a field of computer science to study to handle objects (existing object or to be created) and individual components that works together to satisfy individual goals is called "systems", in a way that supports reasoning about the structural properties of these objects (Golden, 2018). System architecture also define the collaborative way to work each individual component to make possible as single system.

PlantRecog is an image recognition web application for image identification and classification that provides accurate prediction of plant species by using Convolutional neural network algorithms. we are going to included lot of functionality that help to perform PlantRecog application smooth and snappy. First page of PlantRecog web application is home page that define the web application and have basic navigation to make user flexibility to navigate desire working deck. For consistency and human computer interaction principle we are going to use user-friendly color and images that relief to those users those does not want to see high brightness object in the images.

Second features are signup and sign in that make validate and authenticate only privilege user to predict plant species and use this system. Also, capable to creates new accounts of user to use this system. This system capable to validate empty filled, email validation and password and confirm password comparisons validation. And top up the main validation is like name only accept string value. For the convenience reason we are going to develop sign up and sign in in a single page to easily use and navigate registration and login services. In Sing in Page we included additional functionality to recover their password by given email address in forget password page of web application.

Third feature are About us make user to easily find out useful information of PlantRecog application and what are the major feature and attributes of image recognition model. And also, description about what are the main reason to develop PlantRecog application to support and help to innovate botanist to find cure of deadly disease using image recognition web application. We are also going to represents about the basic information of this applications in a about us page.

Fourth feature are Contact us to easily collaborate and contact developer by using messaging feature of web application. In this page we also show and describe location information of PlantRecog application and associated organization to be manage this application. So, student or

related users can easily contact with respective person or organizations. In this contact page any person contacts through give basic information like name, email and messages to admin.
Fifth features are plant details update provides admin as control to update plant details to provides effective information of plant species botanist to resolve the information gaps. This features only available for admin user.
Sixth features are contact message view, this feature provides admins as a control view and read images of the botanist. Most of the website's visitor want to contact and send message admin to know about websites content and information.
Last but not least feature of PlantRecog web application is plant image classification to predict respective plant species class name and description about plant. In this page we used our computer vison model to predict by given input of images to identify images classes. For example, if you give images of rose plant the PlantRecog model predict it is a rose plant and respective descriptions. The PlantRecog application is capable to predict 53 species of plant correctly.

4.2 Abstract Architecture

Abstract architecture is a structural way to representation of system and how this system communicates with different component. In this abstract architecture we cover how system design is beneficial and helpful for development and deployment of PlantRecog application to provide effective services to botanist expert to perform their research. For component wise we cover that the main scratches of system will be going to be develop by using Structural system analysis and design methods to describe the overall functionality and components of PlantRecog applications.

4.3 System Design

Systems design is sub-filed of abstract design (Kautish et al, 2016, 2018, 2019) which deals with components and attributes of a system scheme like components, construction, mechanisms and their related UI interfaces and passed input to support specific functionality. It is a process of developing and conniving systems that can satisfy user requirements and needs to function specific organization (economictimes, 2019). Any software production, there are a lot of engineer hired for design perspective so they can make a complete system architecture and schema to make efficient and effective software application to support business logic. We are going to include context diagram of the overall system to how the system will be function and also included DFD level 0 and DFD Level 1 to describe internal and core functionality of PlantRecog application to how the support and resolve currently facing problem of botanist.

4.4 SSADM

SSADM is a defined as a standard and protocol for system analysis and architectural design (Kautish et al, 2008, 2012, 2013, 2020). It uses logistical formal approach to the constructing, analysis and design of information systems or Information Technology application. It was developed by Learmonth Burchett Management Systems (LBMS) and the Central Computer Telecommunications Agency (CCTA) in 19801981 as a standard for developing British database projects (techopedia, 2019).

4.4.1 Context Diagram or DFD Level-0

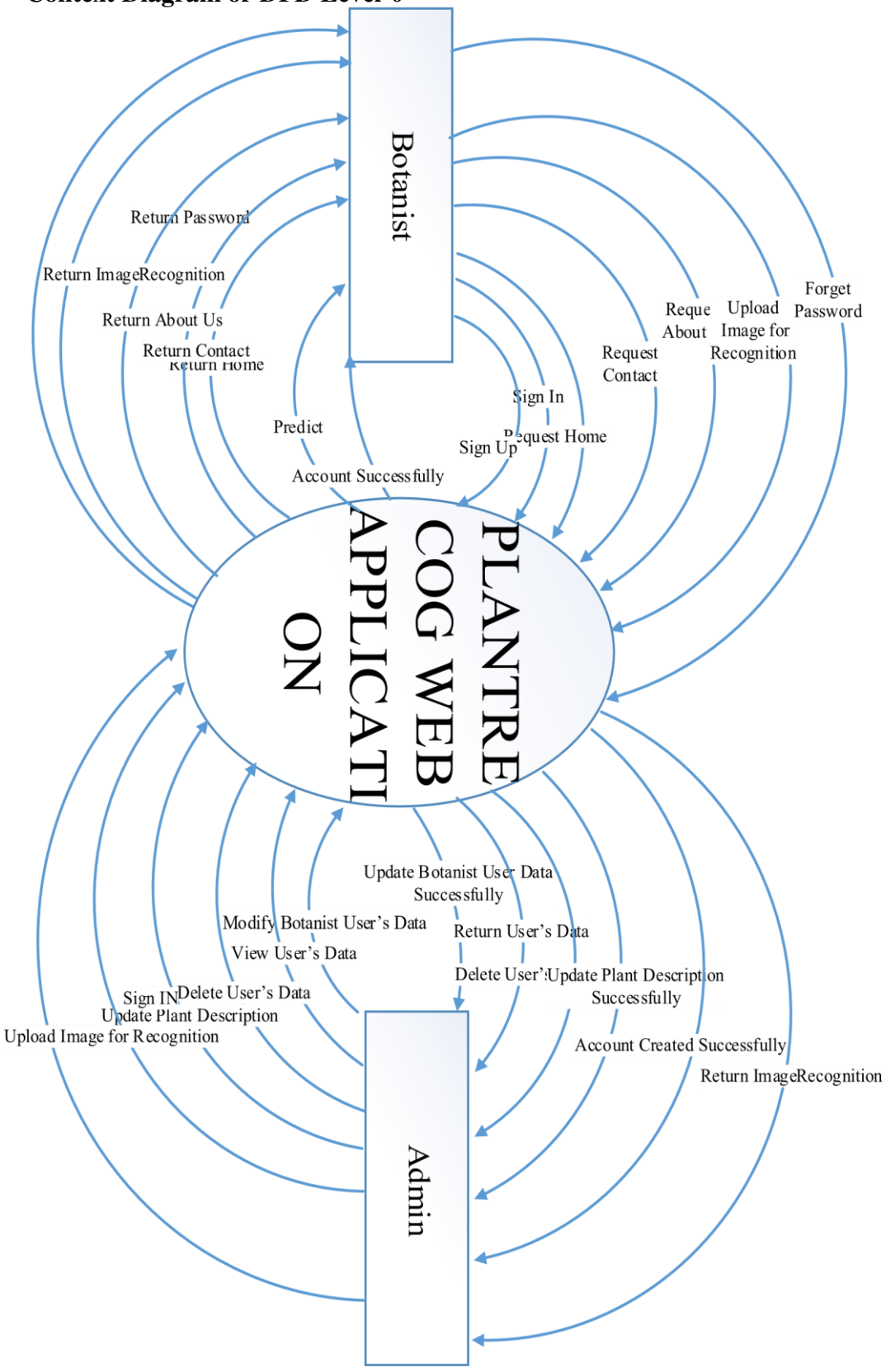

Figure 2: DFD Leve-0

4.4.2 DFD Level-1

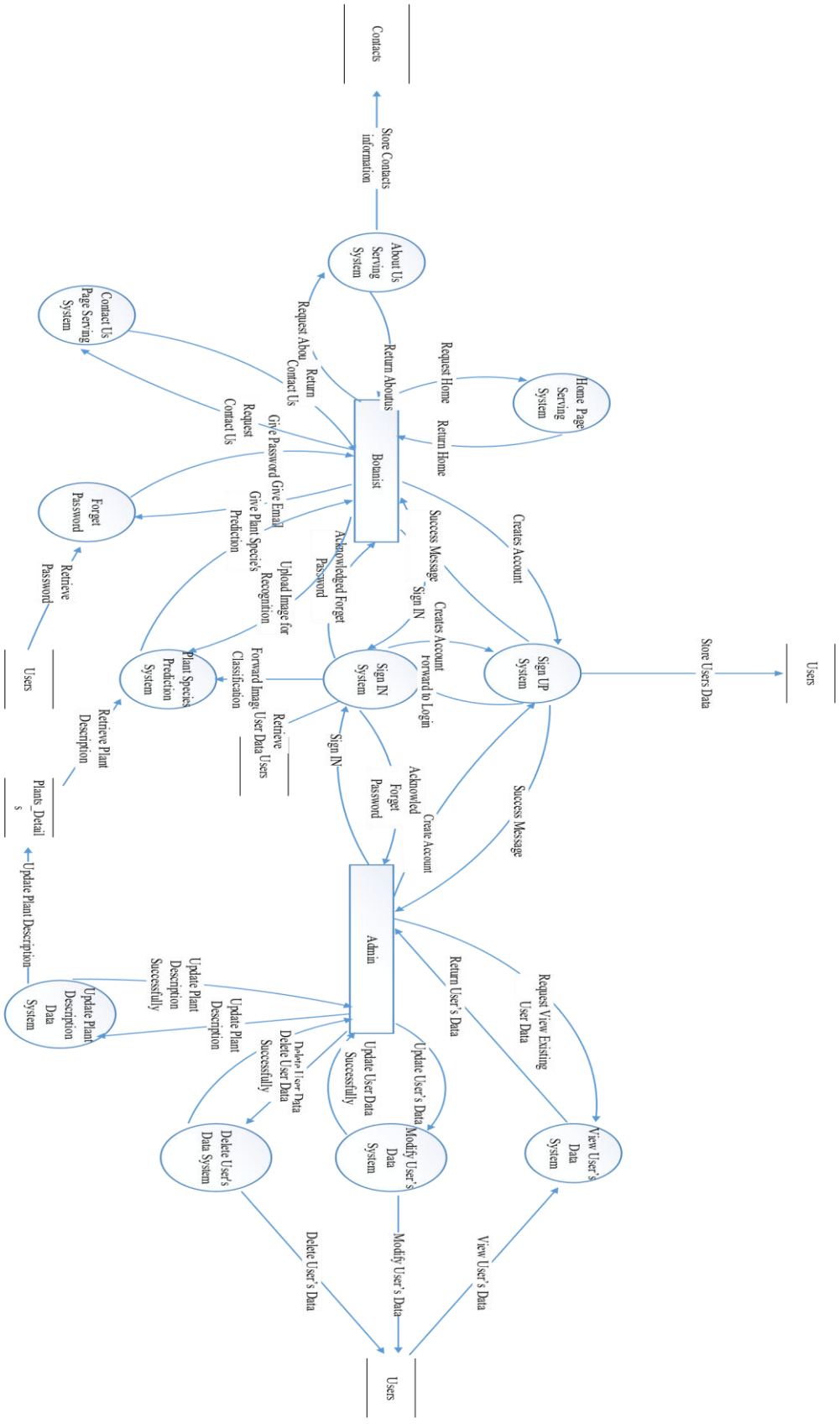

Figure 3: DFD Leve-1

4.4.3 DFD Level-2

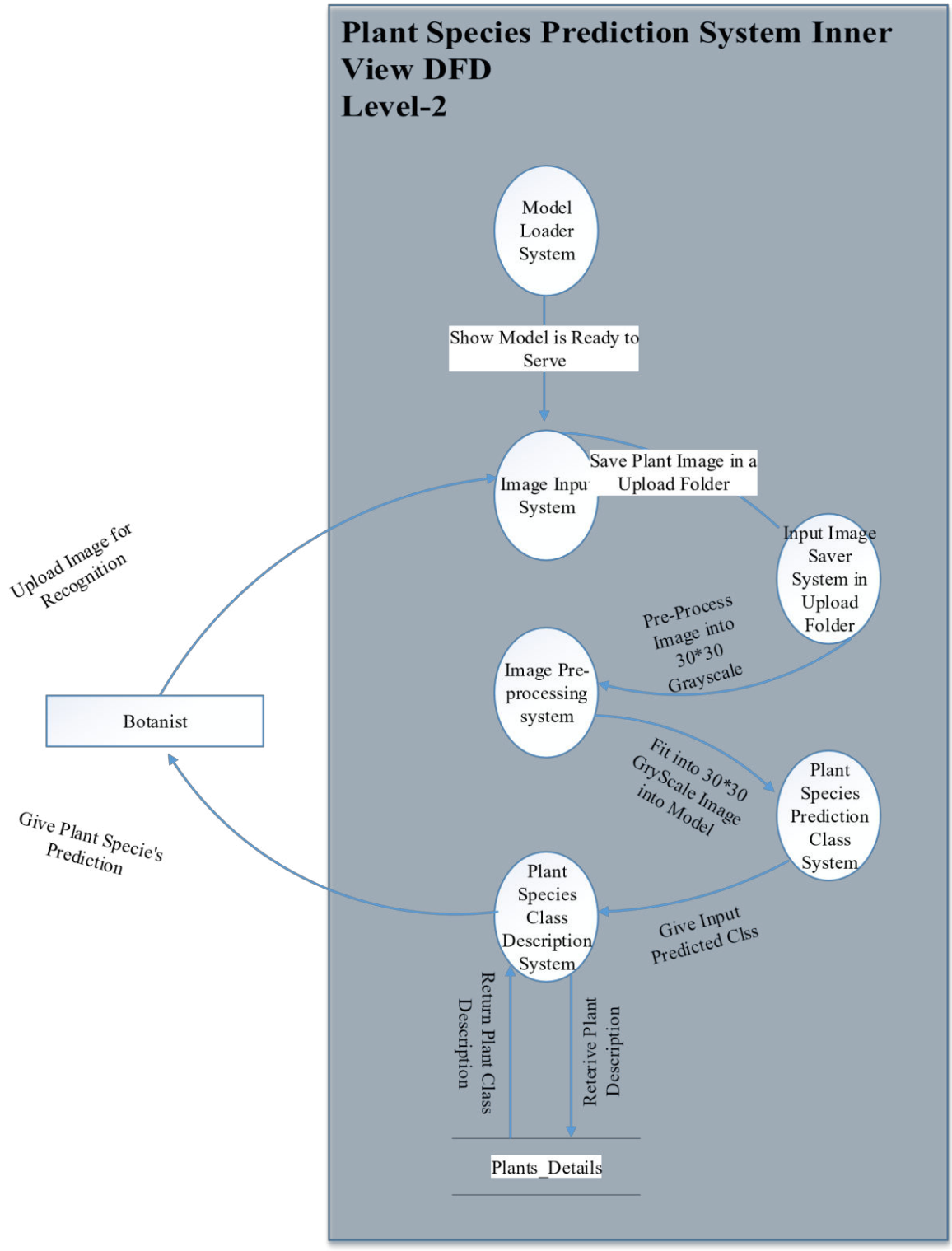

Figure 4: DFD Level-2

4.4.4 Screenshots for Home page

Figure 5: Predict HD page

4.4.5 Description

Home or index page are essential introductory page for web application that help to explain about the why this web application is here. It also links with different pages. So, user can easily navigate and understand work flow of the PlantRecog web application. this home page of PlantRecog web application is link with three different pages such as about us, contact us and signup and sign in page. Home page screenshot is shown in figure below. This page help user to provide roadmap of the PlantRecog application. this page design according to user-centric principle to less or minimal confusion to user while they using this system. For navigation bar we use image logo to identification of PlantRecog application trademarks and corporate best edited background images to make stunning viewing color of webpages.

4.4.6 Sample Codes of Heart Disease Prediction Model Development

```
# import keras library for vectorized and model development
import keras
from keras.models import Sequential,Input,Model
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras.layers.normalization import BatchNormalization
from keras.layers.advanced_activations import LeakyReLU
from keras import backend as K
import tensorflow as tf

# setup configuration of model
batch_size = 8
num_classes = 53
epochs = 15

# input image dimensions
img_rows, img_cols = 50, 50

from sklearn.model_selection import train_test_split
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.30, random_state=42)

print(X_train.shape)
print(Y_train.shape)
print(X_test.shape)
print(Y_test.shape)

'''if K.image_data_format() == 'channels_first':
    X_train = X_train.reshape(X_train.shape[1], 1, img_rows, img_cols)
    X_test = X_test.reshape(X_test.shape[1], 1, img_rows, img_cols)
    input_shape = (1, img_rows, img_cols)
else:
    X_train = X_train.reshape(X_train.shape[0], img_rows, img_cols, 1)
    X_test = X_test.reshape(X_test.shape[0], img_rows, img_cols, 1)
    input_shape = (img_rows, img_cols, 1)'''

#Reshaping Train and test data
X_train = X_train.reshape(-1, 50,50, 1)
X_test = X_test.reshape(-1, 50,50, 1)


X_train = X_train.astype('float32')
X_test = X_test.astype('float32')

X_train = X_train / 255.
X_test = X_test / 255.


print('X_train shape:', X_train.shape)
print('X_test shape:', X_test.shape)
print(X_train.shape[0], 'train samples')
print(X_test.shape[0], 'test samples')


# convert class vectors to binary class matrices
Y_train = keras.utils.to_categorical(Y_train)
Y_test = keras.utils.to_categorical(Y_test)

# convert class vectors to binary class matrices
'''Y_train = keras.utils.to_categorical(Y_train, num_classes)
Y_test = keras.utils.to_categorical(Y_test, num_classes)'''

# setup CNN model configuration
model = Sequential([
    Conv2D(32, kernel_size=(3, 3),activation='linear',padding='same',input_shape=(50,50,1)),
    LeakyReLU(alpha=0.1),
    MaxPooling2D((2, 2),padding='same'),
    Dropout(0.1),
    Conv2D(64, (3, 3), activation='linear',padding='same'),
    LeakyReLU(alpha=0.1),
    MaxPooling2D(pool_size=(2, 2),padding='same'),
    Dropout(0.1),
    Conv2D(128, (3, 3), activation='linear',padding='same'),
    LeakyReLU(alpha=0.1),
    MaxPooling2D(pool_size=(2, 2),padding='same'),
    Dropout(0.1),
    Flatten(),
    Dense(128, activation='linear'),
    LeakyReLU(alpha=0.1),
    Dropout(0.1),
    Dense(num_classes, activation='softmax')
])
# display model configuration correctly setup or not
model.summary()
# configure backpropagation by provide loss function and optimizer
model.compile(loss=keras.losses.categorical_crossentropy, optimizer=keras.optimizers.Adam(),metrics=['accuracy'])
# setup training
model.fit(X_test, Y_test,
          batch_size=batch_size,
          epochs=epochs,
          verbose=1,
          validation_data=(X_train, Y_train))

#Save Everything Including Architecture,Weights, necessary Bias and optimizer and loss functions of whole network
model.save('PlantRecog.h5')
from keras.models import load_model
FinalLeaf50 = load_model('FinalSave.h5')

score = FinalLeaf50.evaluate(X_train, Y_train, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])

FinalLeaf50.save('PlantRecog.h5')
```

5 CONCLUSION AND REFLECTIONS

5.1 Critical Evaluation

Although, PlantRecog web application is among of them one of the most popular plant species identification and classification application to detect by plant shape and texture. This application able to provide basic functionality to deliver best and efficient system to botanist. The main motto of this application is to solve plant detection problem when botanists take sample for research purpose. For the research methods and analysis, we were finding the most difficult to detect plant species and remember the scientific name of the plant species. It is quite difficult to remember all attributes and properties of specific plant species exist in the nature. We focused and deliver to solve those kinds of problem by the help of image classification of neural network which is associated the field of computer vision.

This application is able to identify and classify the 53 kinds of plant species exists in nature. Also, it will be providing details description of the plant species when botanist check sample of the plant image. The major obstacles of the image detection and recognition is too difficult to color segmentation of plant images because most of the plant species are green. It is quite difficult to understand distinguished between the color, texture and shape-based classification. this application is only acceptable for basic identification and image recognition purpose not for do every task which is needed to store detected plant species. the good sides of the PlantRecog application it comes with full pledge sign in, signup, contact us, about us, view plant data, update plant data, view messages functionable model to support real-world authentication and data validation. That makes system as less vulnerable to attack.

Today era is known as science and technological generation that make life easy and convenience for everyone. And the full filled of that purpose we make PlantRecog application to make life easier for botanist researcher while difficult to take sample of plant image. Along research and development some glitch is residue are still presence in the PlantRecog application which is better is known as limitation. The major limitation is, it can only recognize 53 plant species because we train them only 53 species sample. For current time the main or huge problem of image classification. We need to retain iteratively the model to satisfy the plant species detection. Second limitation is we could not able to achieve the more than 86% accuracy of PlantRecog application predication. Third limitation is not guaranteeing the detect sample is 100% recognized plant species because there is also 14% inaccuracy. This application is giving tentative plant species scientific and their descriptions.

Fourth limitation is it could not validate the image contain object like if you give dog image sample it should not tell you it is not a leaf because we don't find that methods and function can achieve that objective. For future version of PlantRecog application we also work on that project. For the time limitation we could not able to deliver functionality.

Last but not least, we will make that system for useable to deliver a basic functionality and strength performance to user while working this system. This system has its own positive and negative side we are already discuss in second or third paragraphs. Also, we want to explore to solve that limitation to make full pledge complete PlantRecog web application to support botanical research.

5.2 Conclusion

Finally, we are able to do complete research and analysis of how we can develop PlantRecog application by using Convolution neural network and its development strategy. We also faced challenges along the way of development. As context of project achievement, we achieved a complete software development process to resolve real-word existing problems. Image recognition and classification huge usage to solve real-world identification problems. Finally, we are able to creates a classification model which take input image by 50*50 greyscale plant species image and produce output of the predicted class name respective to detect by leaf shape and texture. This application is use powerful libraries like TensorFlow which is work on the backend of keras high level of the library.

For research outcomes and analysis, we were completed research that is fully satisfy our objective and gives us clear insight about the overall process and features require to develop PlantRecog applications. There is no laciness of the research design will be need to overcomes and restructure to find new insights. We make question is very reasonable and hits a point what we want to achieve to satisfy the overall process and objective of development PlantRecog application. our main aims of this research were to focus on botanist existing problem and what are the expected solutions that make life easier for botanist.

For the main laciness of the PlantRecog application is we don't have enough time to devote complete technical research to how we can validate to only take sample of plant species kinds of images by model. We want to further explore those images contains object validation by using images feature extraction. We will solve those problem in the future version of the PlantRecog application to solve complex problems.

5.3 Future Work

PlantRecog will be the most flexible application for detecting and identifying plant species by leaf images. For future improvement and enhancement, we will possible to make to increase the sample of plant images to train large datasets. To make best and accurate prediction of any kinds of plant species. Another option is combined with different plant recognition model to process images by pre-train model and internetworking to produce best and accurate results. We also focus on how we can tune the best way to produce the best and accurate model according to leaf shape or texture. If time available, we will develop such Botanist community site that helps to encourage and communicate through community page. We also focus on how we can create such image validation system to only take plant species image otherwise through error message to botanist.

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