CHAPTER 01

INTRODUCTION

1.1 OVERVIEW

Generally, cropping patterns are mostly based on weather conditions and also on the composition of the soil. So selecting the crop based on the upcoming climating conditions and suitable for the type of land chosen, we can yield better than other crops and increase our profits. In recent years, researchers have run missions such as weather forecasting and soil composition testing. By taking into account the available data, our study evaluates a wide range of weather figure methods, soil composition methods, and cropping pattern ways. Due to changing weather conditions and soil compositions, determining precise cropping patterns has become a difficult issue. Study on different machine learning algorithms has been done to build a model that will suggest the best set of crops that can be grown in the given conditions.

1.2 MOTIVATION

- Agriculture is extremely important to the Indian economy, accounting for 18% of the country's overall GDP.
- Inaccurate selection of crops due to lack of knowledge in weather, soil and crop cultivation leads to wastage of food and hence the profits also decreases.
- Unhealthy and hindered growth of crops due to selection of inappropriate time for sowing seeds.
- Due to sudden changes in climatic conditions the crop planted by farmers gets damaged.
- All the above reasons lead to decrease in the country’s GDP.

1.3 PROBLEM DEFINITION & OBJECTIVES

1.3.1 Problem Definition

The Indian economy relies heavily on agriculture. It is responsible for 18% of India's total GDP. The bulk of crops in India are completely weather-dependent. As a result, by analysing agro-climate data using machine learning algorithms, increased crop

production can be produced. These days, due to drastic change in weather conditions crops are getting damaged. Also, nowadays it is difficult to meet people's needs as the population is increasing day by day. To overcome this situation we have come up with a technique which will help farmers to analyse weather conditions and fetch the soil composition to cultivate the right type of crop and maximise their crop yield.

1.3.2 Objectives

- Getting real time data for upcoming weather conditions using machine learning models.
- Suggesting users with most suitable crops based on the gathered data of various weather parameters and soil compositions.
- Also suggesting the user with appropriate time for cultivation.
- Proper selection of the crop will increase in the yield rate and profits will also increase.

1.4 PROJECT SCOPE & LIMITATIONS

1.4.1 Project Scope

- Getting real time data for upcoming weather conditions using machine learning models.
- Suggesting users with most suitable crops based on the gathered data of various weather parameters and soil compositions.
- Weather conditions local to user’s provided location will be taken into consideration while suggesting appropriate crops.

1.4.2 Limitations

- Current regions limited to Sangli, Nashik, and Kolhapur districts of Maharashtra.
- Variety of crops suggested are limited to crops grown in the three regions mentioned above.

- Application Interface only available for Android mobile platforms.

1.5 METHODOLOGIES OF PROBLEM SOLVING

We studied the different conditions that affect crop nourishment and ended up selecting a set of parameters that most affect crop growth. We selected a set of soil and weather parameters that were most relevant to our project. From soil, we selected pH, NPK parameters. However, we later dumped NPK due to its data paucity. From weather, we selected Temperature, Humidity and Rainfall.

We selected crops that grow in the three initial regions that we selected and gathered their pH, temperature, humidity, and rainfall requirements from various trusted sites and created a dataset of our own. We then built a model using this dataset and created an Android application as a user interface which the farmers can use with ease to get crop suggestions.

CHAPTER 02

LITERATURE SURVEY

In [1] The author employed a Recurrent Neural Network with LSTM for seasonal weather predictions, and a random forest classification technique to categorise viable crops. The author used the NRSA Hyderabad station's dataset for weather prediction, which has five years of data and includes variables like temperature, humidity, sun hours, wind speed, wind direction, and so on.

In [2] The author created a rainfall study using time series analysis and hybrid ARIMA (Auto Regressive Integrated Moving Average) techniques. This method can be used to extract and develop characteristics from time series data in a simple and straightforward manner. The data was also used to develop a rainfall forecasting model by the author.

In [3] the author attempted to use the Hidden Markov Model to figure out exact climate conditions for our erratic climate changes in India. The Hidden Markov Model is currently being used to forecast weather using the Markov Chain Property.

In [6] Using essential technologies such as genetic algorithms and FFT, the author developed an android app for user registration and it will take weather conditions based on the user’s location through the GPS system. Then the proposed model will send the pre-post activities to be done by the user for cultivation. Also the author is sending crop damage and weather alerts to users via sms or email.

In [7] ARMA (Auto Regressive Moving Average), SARIMA (Seasonal Auto Regressive Integrated Moving Average), and ARMAX (Auto Regressive Moving Average plus Seasonal Auto Regressive Integrated Moving Average) were the three methods that the author compared (ARMA with exogenous variables). The author will also employ the highest performing algorithm for predicting rainfall and temperature and applying it to optimal agricultural practices.

Seasonal crops, whole-year crops, short-term plantation crops, and long-term plantation crops are all classified as seasonal crops in [10]. The author utilised the Crop Selection Method to calculate the net profit / yield rate of crops across the season (CSM).

In [11] The author proposed an all-encompassing model with a majority voting technique for picking a culture for site-specific parameters with amazing precision and efficacy, using CHAID, K-Nearest Neighbour, and Naive Bayes as learners. To choose the crop to be cultivated, they merely looked at soil factors.

In [12] The author developed a model that aggregated the weight of parameters and chose the best crop to cultivate on land using an AHP and TOPSIS mixed technique. The AHP approach is used to generate parameter priority weights, while the TOPSIS method is used to create a sequence alternative. Green beans are the top priority outcomes derived from the alternative of 11 parameters based on calculations utilising the AHP and TOPSIS combined methodologies. This proposed methodology can address the issue of recommending a crop that is good for both wet and dry soils.

In [13] The author divides soil into two categories based on macronutrients and micronutrients, and then forecasts which crops may be cultivated in each. The bagged tree algorithm is used for soil categorization.

In [14] the proposed model can predict the correct soil series and cultivation for a particular field in a very effective manner. Classification of soil by using K-Nearest Neighbor (KNN) algorithm.

CHAPTER 03

SOFTWARE REQUIREMENTS SPECIFICATION

3.1 ASSUMPTIONS AND DEPENDENCIES

1. **Operating System -** The application will be developed for android platform only. Android 5.0 (Lollipop) and upper versions can support this application. Therefore covering these android devices will result in covering 94.1% of the smartphone market.
2. **Weather conditions** - The application will give better results if there are no abrupt changes in weather conditions and the changes in weather are gradual according to the previous years reading in the dataset.
3. **Internet Connectivity** - The application needs good internet connectivity for fetching the current weather conditions from the weather api and also for fetching user details and the selected crop details from the database.

3.2 FUNCTIONAL REQUIREMENTS

3.2.1 Login User

If the user is already registered in the software system's database then by providing valid username and password, the user can get access to his / her account and can process further activities. The system of the software will check for the validation of the data provided by the user during login activity and process further accordingly.

3.2.2 Register New User

If a new user wants the access of the software he / she needs to create an account on the software by providing the necessary information which will automatically get saved into the system database and the new user will get logged into the system by providing valid information. The system will check the validity of the information by itself as soon as the user provides with the information and notify the user accordingly.

3.2.3 Get Location

Whenever the user wants to get the crop suggestions for cultivation, the first step provided by the software system is to get the location of the area in which the user wants to cultivate the crop. Two options will be provided to the user: first is to get the current location of the user and the second is to enter the location manually of the area to be cultivated and hence the user has to choose between them accordingly.

3.2.4 Get Current Weather Conditions

As soon as the location of the area is provided by the user then the system will get the current weather conditions of that area and further preprocessing steps are applied on the current weather data and then it is given further to the weather forecasting model.

3.2.5 Predict Future Weather Conditions

The weather data collected will help the weather forecasting system for prediction of the future weather conditions and then accordingly the weather parameters are collected from the weather forecasting model as output and given for further processing.

3.2.6 Get Soil Data

At the same time the user can collect the soil data from a nearby soil testing centre. The values are then pre-processed and sent to the system.

3.2.7 Appropriate Crop Prediction

Based on the weather and soil data collected and preprocessed the appropriate crops will be suggested to the users with the help of crop classification model and then the user can select any crop according to his / her need from the list of crops suggested by the system.

3.3 EXTERNAL INTERFACE REQUIREMENTS

The app will be written in Java and will make use of the Android SDK. Additionally, Android Studio will be utilised as the project's IDE.

3.3.1 User Interfaces

Our application's user interface will be simple to use and comprehend. The user must be familiar with Android devices and be able to send and receive messages as well as use buttons. The following sections go over user interfaces in greater depth-

3.3.1.1 Login Interface - In this interface, there will be two inputs username and password two buttons one for login and the other for register. If the user is not registered to the application, he / she will use the register button and the register interface will open where the user can register themselves. Whenever the user clicks the login button the system will check for validity of the data and work accordingly.

3.3.1.2 Register Interface - In this interface, the user registers with the system by filling out a text field with personal information. A button register will be present. After filling out the required fields with the user's personal information (username, password, gender, etc.), the user can click the register button to access the programme.

3.3.1.3 Location Interface - In this interface the user will be asked for his / her agricultural areas location, there will be two options one is to get the current location of the device in which the application is running and the other is to enter the location manually. Users can choose any of the provided options and proceed.

3.3.1.4 Profile Interface - In this interface the user can see all the information related to his / her account and also if the user wants to update any information or data within it then by clicking the edit option user can update any information according to his / her own will.

3.3.1.5 Display Result Interface - In this interface the system will get current weather conditions and generate future weather data and also the system will get the soil composition from the user and the combined result will be given to the crop classifier model and it will display a list of suitable crops. By selecting any crop from the

suggested list, the user will get all the related information of the selected crop along with the appropriate time for all the agricultural activities.

3.3.2 Hardware Interfaces

The app is compatible with Android smartphones and tablets. Hence the only hardware required for efficient implementation of the application are Android mobile devices and tablets.

3.3.3 Software Interfaces

- Because this is a mobile application, it requires Android 5.0 (Lollipop) or higher to function properly.
- Because the main application is a mobile application, the Android Studio IDE is the finest IDE for android application development.
- This application also needs two machine learning models (for weather, and crop) to get essential results and for development of these machine learning models we will require the Jupyter Notebook IDE.

3.3.4 Communication Interfaces

To communicate with Android devices, this app uses Wi-Fi Direct.

3.4 NON-FUNCTIONAL REQUIREMENTS

3.4.1 Performance Requirements

The user needs to have good internet connectivity for our application to be able to fetch the weather data as well as login the user into their respective account. However, the application can work perfectly fine even with a low internet connectivity. Android version 5 and above is preferred for best performance.

3.4.2 Software Quality Attributes

- The application size is very low and hence does not take up any significant storage space.
- The application can be easily downloaded by an online app store.
- The application works perfectly fine on any Android device provided its version is above 5.
- The application is very simple and easy to use without any unnecessary complications.

3.5 SYSTEM REQUIREMENTS

3.5.1 Database Requirements

The system must save all of the user's account information, as well as the user's location, weather, and soil condition details. The database generated during the development process will be used to hold all of the data.

The loginID, name, password, age, email address, and other information for each user account must be maintained in a table with the same name, and all entries must be organised alphabetically by loginID. Furthermore, there will be a user location table with which additional weather and soil information can be obtained using both software and hardware.

Example of tables in databases are as follows:

UserID	**Name**	**Password**	**Email**	**…**
101	Gourav Patil	**********	abc@xyz.com	…
102	Niraj Sawant	**********	pqr@xyz.com	…

Table No. 3.5.1.1 UserAccount Table

UserID	Location
101	Kolhapur
102	Pune

Table No. 3.5.1.2 Location Table

3.5.2 Software Requirements

- Because this is a mobile application, it requires Android 5.0 (Lollipop) or higher to function properly.
- Because the main application is a mobile application, the Android Studio IDE is the finest IDE for android application development.
- This application also needs three machine learning models (for weather, soil and crop) to get essential results and for development of these machine learning models we will require the Jupyter Notebook IDE.
- The system will collect the soil composition from the various IoT sensors used. Hence to code for getting accurate data from IoT sensors to Micro Preprocessor we will be needing an interface for that and also raspbian OS for efficient execution of that code.

3.5.3 Hardware Requirements

The application works on Android mobile devices and tablets. Hence the only hardware required for efficient implementation of the application are Android mobile devices and tablets.

3.6 ANALYSIS MODEL: SDLC MODEL

For this project, we employ WaterFall Software Development Modelling, often known as a linear sequential life cycle model. Each step must be completed before going on to the next in a waterfall model, and the phases do not overlap. The waterfall model presents the software development process as a series of events that occur in a logical order. This

means that each step of the development process can only begin once the preceding one has completed.

The sequential phases according to WaterFall Model for this project -

3.6.1 Requirement gathering & analysis -

- Gathering information about which factors influence crop growth.
- Gathering information about requirements of a set of selected crops.
- Gathering information about different Machine Learning algorithms.

3.6.2 Design -

In this phase, we design different diagrams such as Data Flow Diagram,etc design the System Architecture, and plan on how we will execute our project.

3.6.3 Implementation -

We divide the task among our team members and work on individual elements of the project such as Android application development, dataset creation, training machine learning model, and working on some additional APIs.

3.6.4 Testing -

We test each of the individual elements and check if they are compatible with each other and make necessary changes along the way. We test our modules against different circumstances like checking the predicted crop for various distinct parameters and comparing results.

3.6.5 Deployment -

We combine all individual modules and the software/application is ready.

3.6.6 Review -

After receiving some feedback, we make some minor changes or add some small additional features to the application.

CHAPTER 04
SYSTEM DESIGN

4.1 SYSTEM ARCHITECTURE

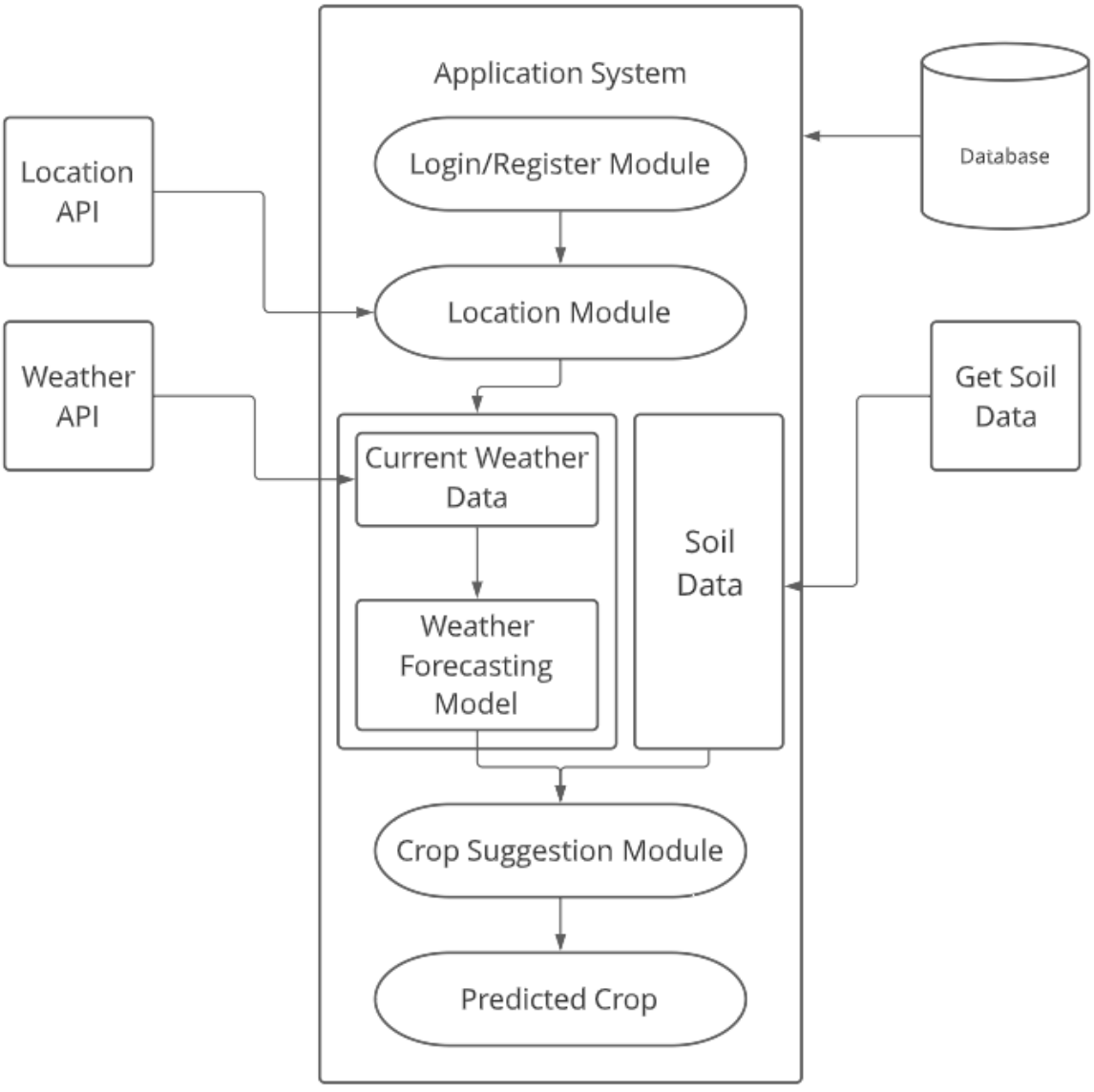

Fig 4.1 System Architecture

4.2 UML DIAGRAMS

4.2.1 Data Flow Diagram

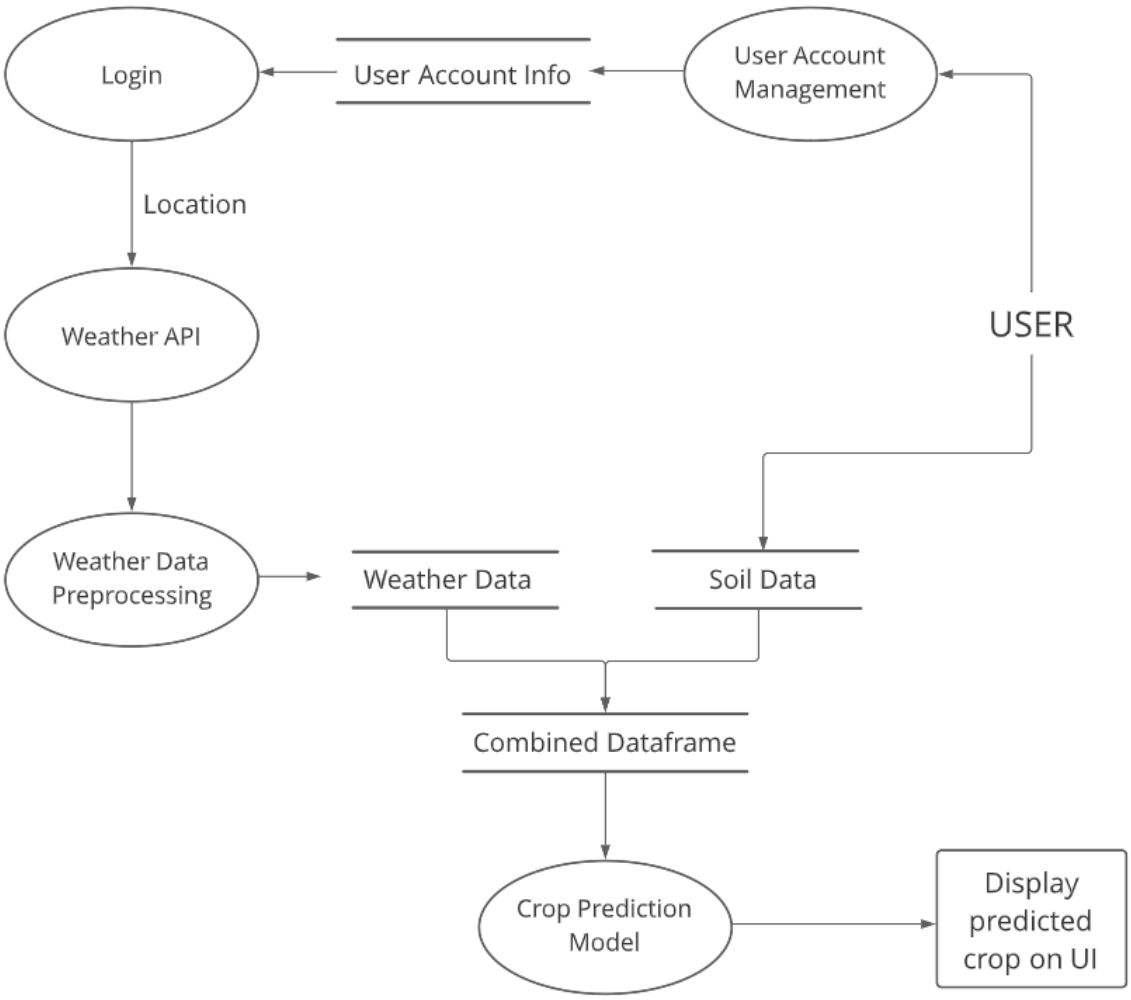

Fig 4.2.1 Data Flow Diagram

4.2.2 Deployment Diagram

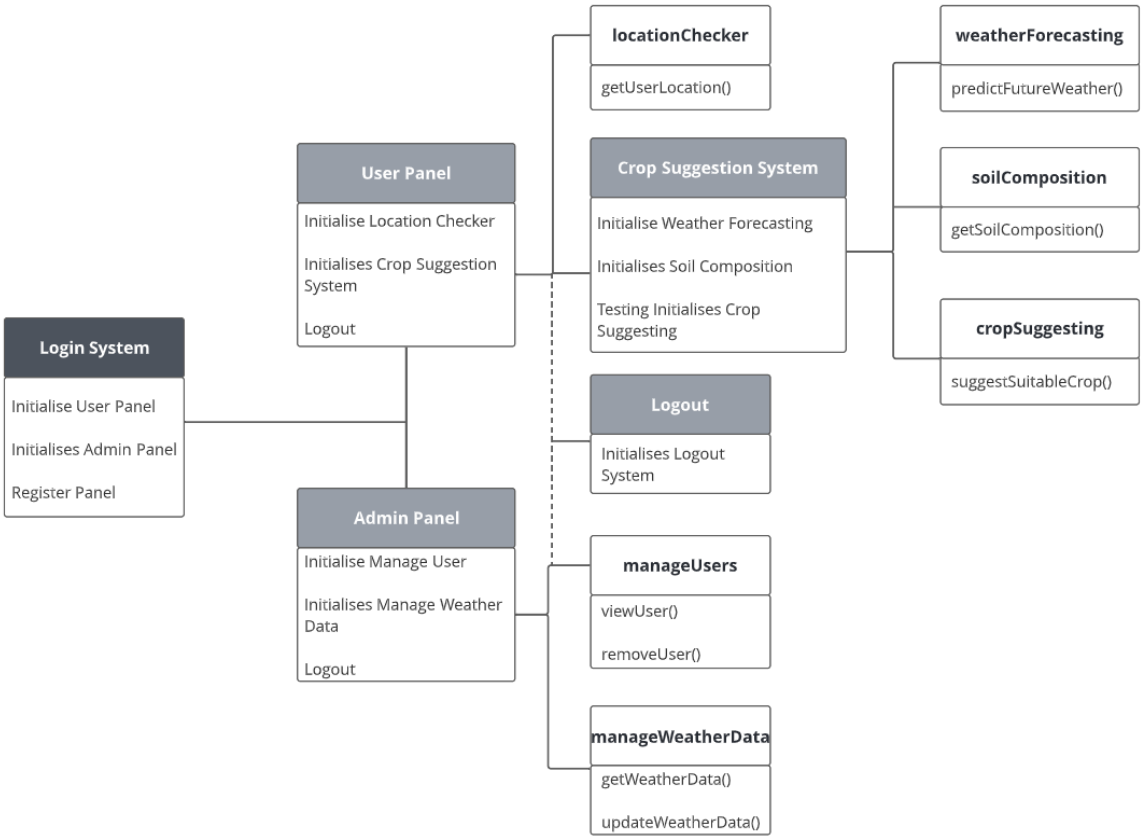

Fig. 4.2.2 Deployment Diagram

4.2.3 Component Diagram

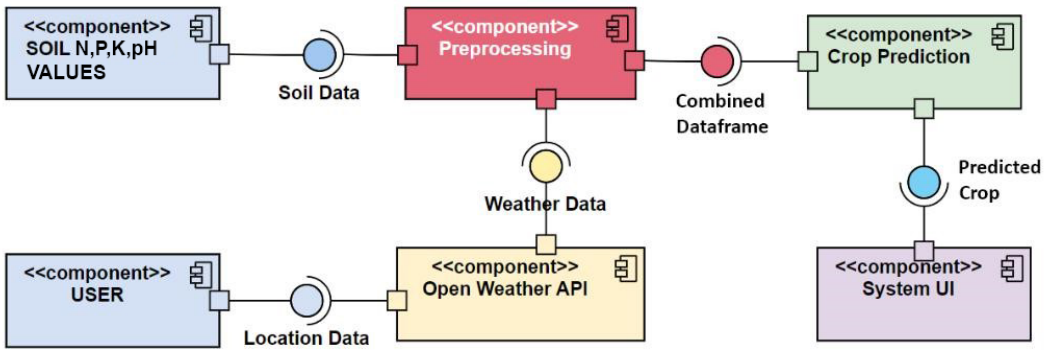

Fig 4.2.3 Component Diagram

4.2.4 Class Diagram

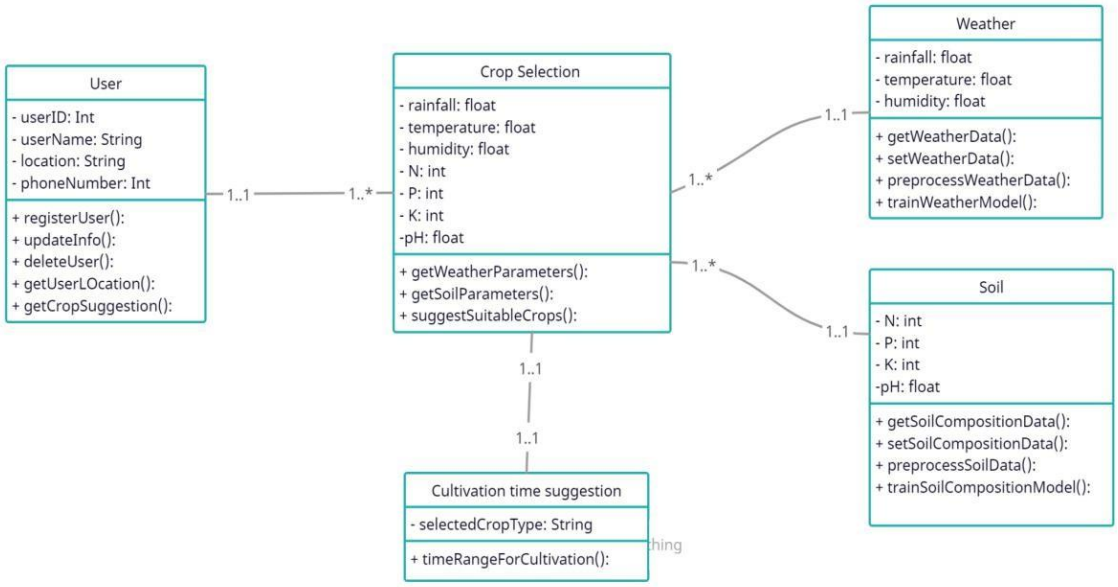

Fig 4.2.4 Class Diagram

4.2.5 Sequence Diagram

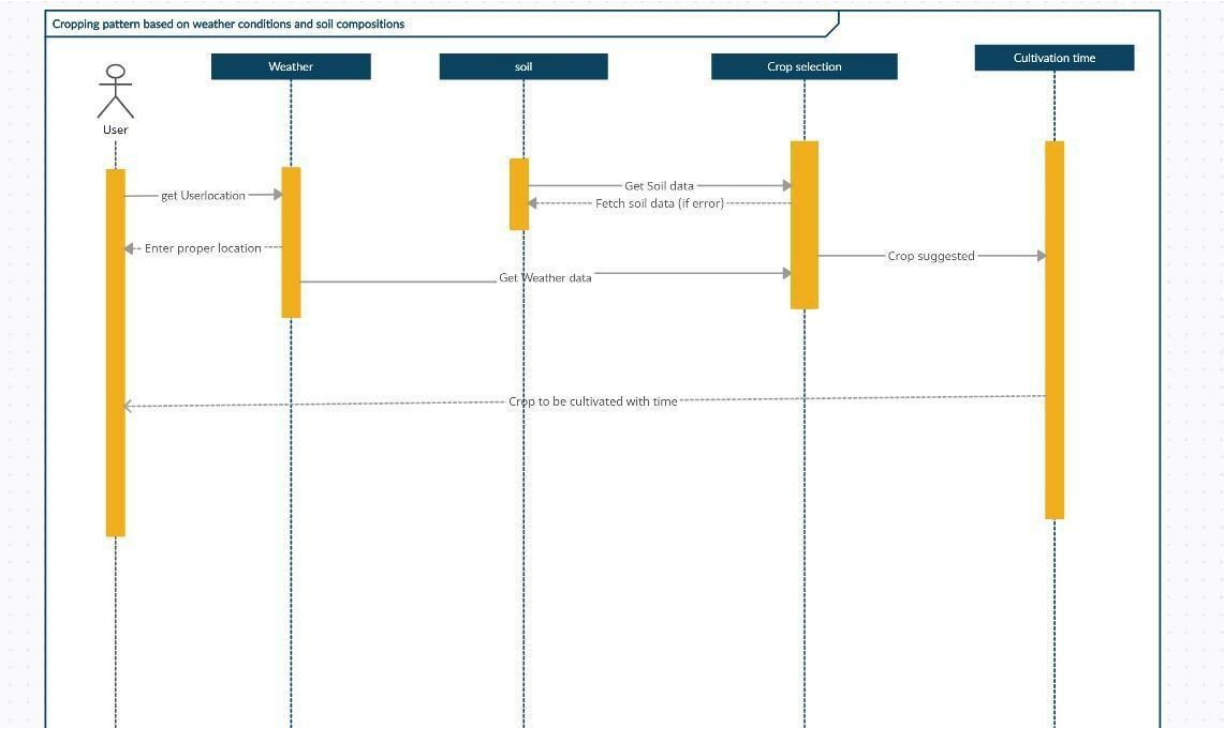

Fig 4.2.5 Sequence Diagram

4.2.6 Use Case Diagram

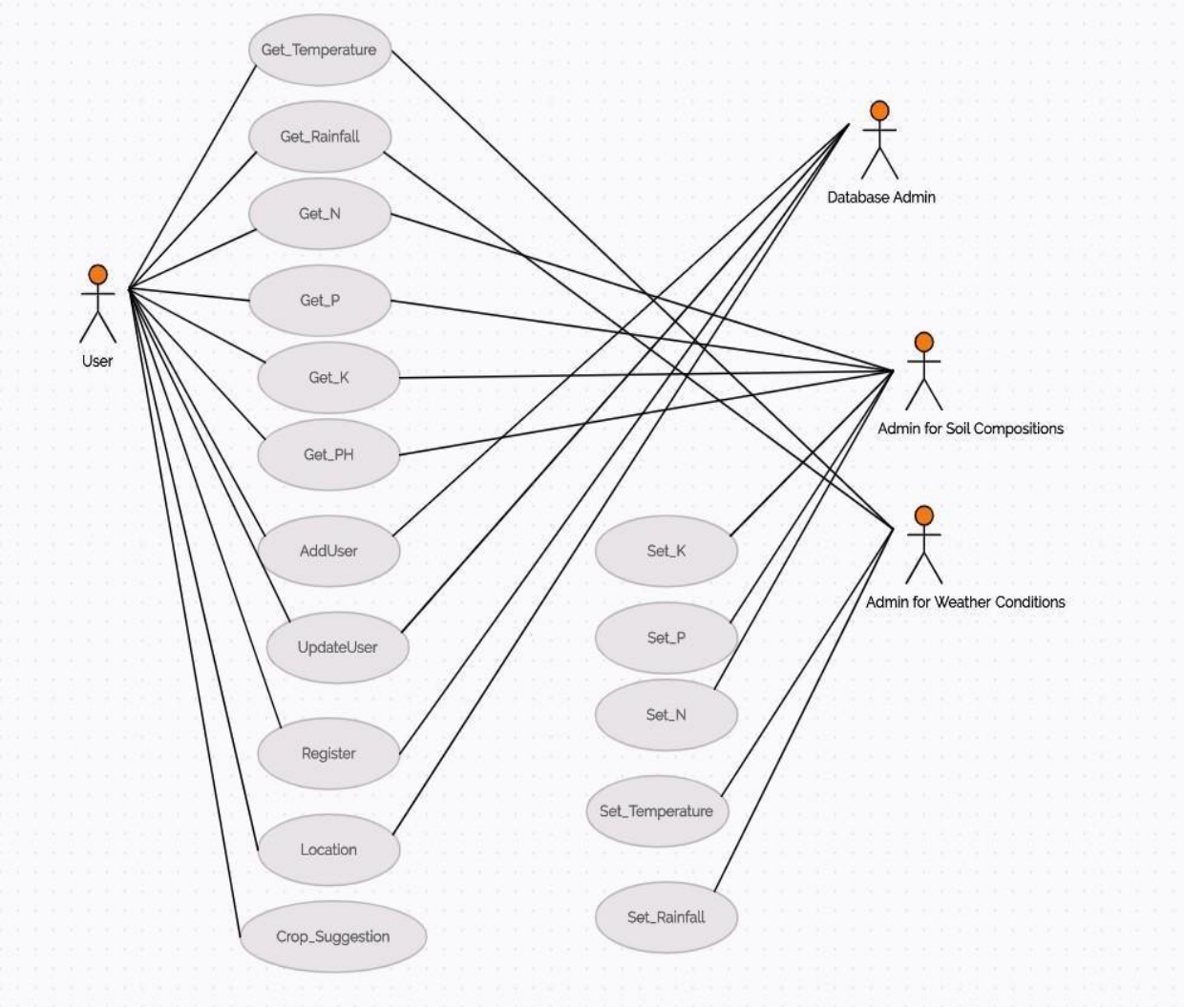

Fig 4.4.1 UML Diagram

CHAPTER 05

PROJECT PLAN

5.1 PROJECT ESTIMATE

5.1.1 Reconciled Estimates

We have divided our estimates into cost and time estimates. Since all resources that were used to make the project were either Open Source or already available, the total cost to make this project is zero.

5.1.1.1 Time Estimates

Month	**Activity**
July 2021	Searching for topic
	Researching about the feasibility of the topic
	Studying in depth about crop cultivation
August 2021	Researching about the most relevant parameters to consider for crop cultivation
	Studying research papers on the same topic
September 2021	Devising a plan to execute the project
October 2021	Working on creating the dataset
November 2021	Training the created dataset with various machine learning algorithms and comparing results
December 2021	Publish a paper in a journal
	Create the Weather API
January 2022	Create the Android Application UI
February 2022	Integrate all modules and testing
March 2022	Debugging and working on some errors
April 2022	Making project report

Table 5.1.1.1 Time Estimates

5.2 RISK MANAGEMENT

5.2.1 Risk Identification

The very first risk we faced was in creation of the dataset. There is no combined dataset available on the internet, there is one available on Kaggle but faces the issue of not being realistic. We wanted to make a model that would be helpful in real life applications and hence had to decide to prepare our own dataset.

Data about specific conditions required for a given crop are spread across various websites and there is no single source that provides all reliable information. A lot of surfing through the internet was required to acquire accurate data.

Finding a reliable weather data service provider since a lot of them have many features locked behind premium subscription. So, finding a reliable free source was a challenge.

5.2.2 Risk Analysis

We counted our options and decided to do more research into the specific domains of weather and soil themselves and analyse them to figure out some clever alternatives that would fit our project well. In the end, we were able to suppress some risks and even completely solve some.

5.2.3 Overview of Risk Mitigation, Monitoring, Management

- For our data preparation, we decided to rely on government agricultural websites and got all valuable information from them. With this we got all growth requirements for all crops that we selected and with a bit of Python code, we successfully made our own dataset.
- We found a reliable weather data provider, we got weather data of the past 10 years to train our weather forecasting model.

5.3 PROJECT SCHEDULE

5.3.1 Project Task Set

The project can be divided into these main tasks -

Task 1: Parameter Requirement Analysis

Task 2: Project Specification (Paperwork).

Task 3: Technology Study and Design.

Task 4: Coding and Implementation (Module Development).

5.3.2 Task Network

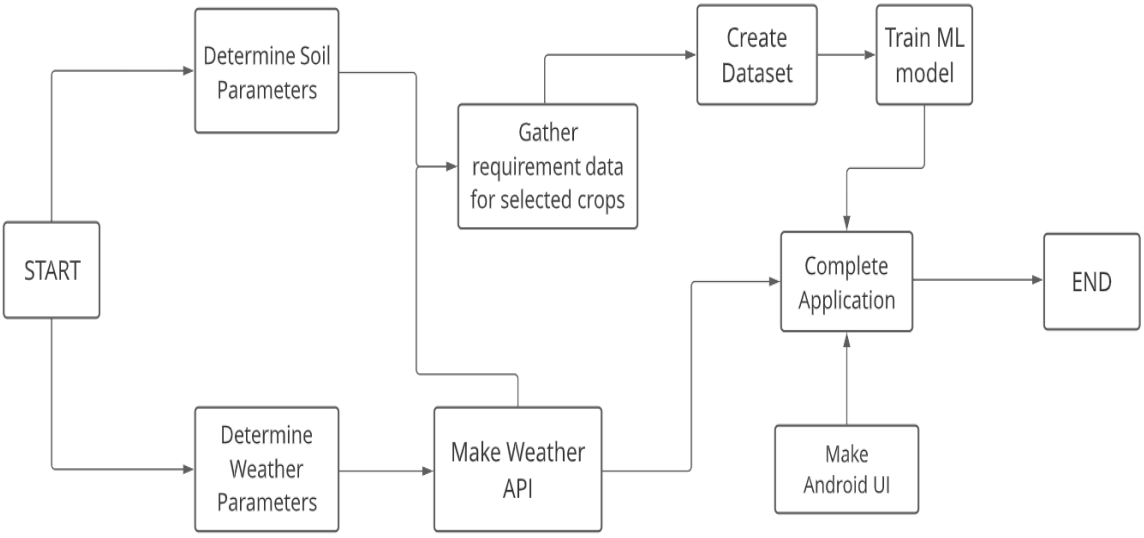

Fig 5.3.2 Task Network Diagram

5.3.3 Timeline Chart

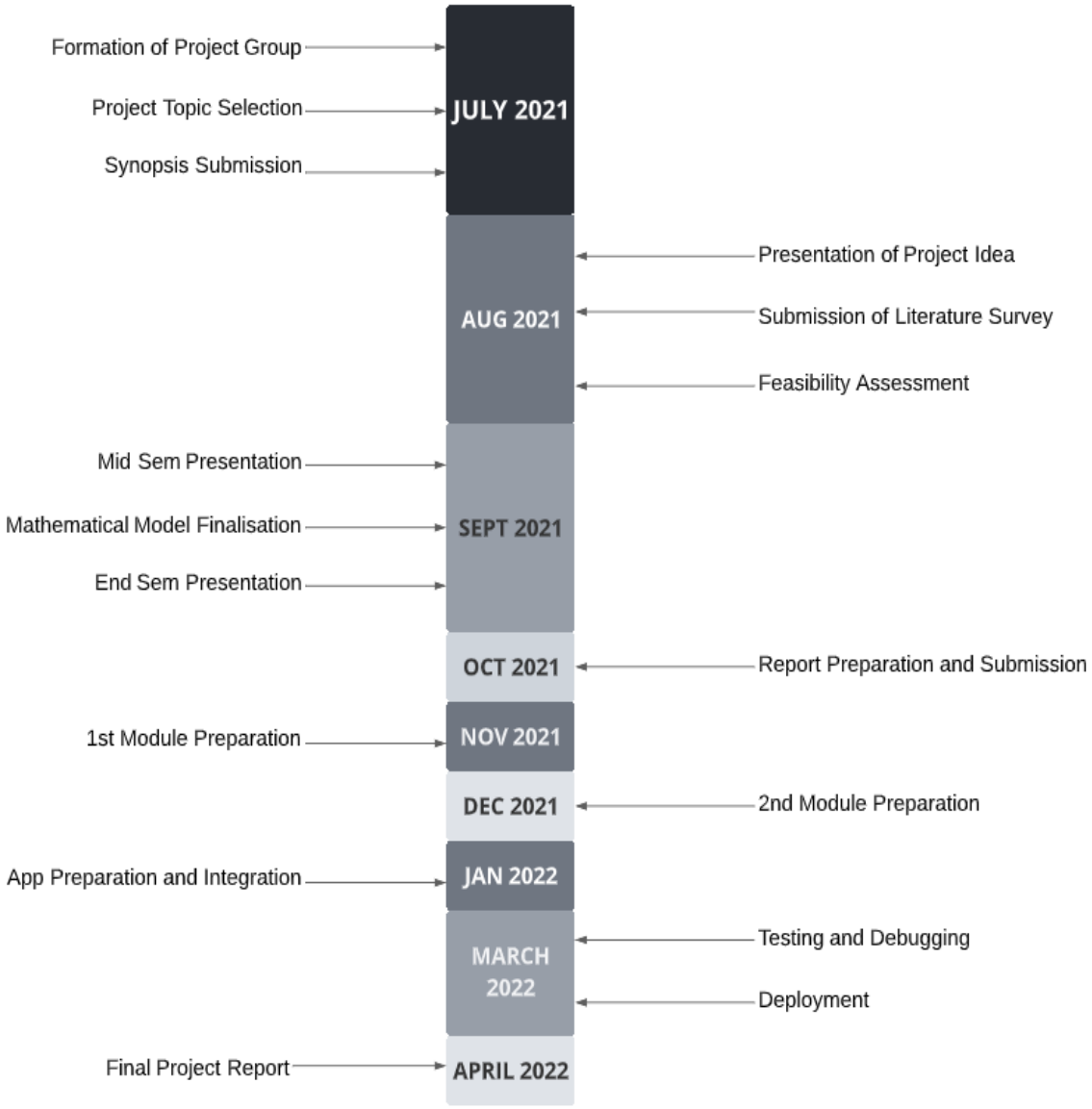

Fig 5.3.3 Timeline Chart

5.4 TEAM ORGANISATION

5.4.1 Team Structure

Prof. Rajesh Lomte	Project Guide
Gourav Patil	Android App development, Weather API module
Niraj Sawant	Dataset creation and Requirement Analysis
Chaitanya Patil	Training of ML model using various algorithms
Siddhant Mane	Project Report and Testing

Table 5.4.1 Team Structure

5.4.2 Management reporting and communication

- Created a shared Google Drive among team members. All files related to each individual's task were uploaded on this shared drive so that each team member can access it at will.
- Conducted weekly meetings on Google Meet among team members discussing each individual's progress on their respective tasks.
- Conducted regular meetings with our guide discussing our progress and taking into consideration the improvements suggested by our guide.
- Sometimes tasks would be swapped between members depending on which member can better handle the issues associated with that task to minimise time utilised to solve the issue.
- Suggesting improvements to each other's tasks thus improving the overall performance.

CHAPTER 06

PROJECT IMPLEMENTATION

6.1 OVERVIEW OF PROJECT MODULES

There are three main implemented modules in our project

1. **Login Module -** This module handles user account management and functions as an authentication system for any user to use the application. This module also helps the app to gather more data to further improve our model.
2. **Weather Module -** This module is responsible to fetch the active weather conditions for a given region and also perform weather forecasting based on the active fetched weather data.
3. **Crop Prediction Module -** This module takes in input all the soil and weather parameters and suggests a set of crops that will grow best in the given conditions.

6.2 TOOLS AND TECHNOLOGIES USED

These are the list of technologies and tools that we used throughout our project -

- Python - We use python as our programming language to create our dataset and also train our crop prediction model.
- Scikit-learn - A python library used for machine learning. It has various in-built machine learning algorithms and was used to train our model.
- Android Studio - A platform used to create Android Applications.
- Java - Programming language used to build the Android application for backend.
- XML - Programming language for UI part of Android application.
- Postmaster - SQL Backend
- Firebase - Handle the various databases implemented in the application.

6.3 ALGORITHM DETAILS

6.3.1 Recurrent Neural Network (RNN)

The output from the previous step is provided as input to the current step in a recurrent neural network (RNN). RNN has a "memory" that stores all information about the calculations.

Recurrent Neural Networks algorithm will be used for development of weather forecasting model. RNN algorithm gives highest efficiency as compared with other weather forecasting algorithms in comparison with accuracy of the output.

Input -

1. Current weather conditions that are fetched using the Weather API.
2. Time Duration for which the weather needs to be forecasted.

Output -

1. The forecasted weather condition for specified time duration.

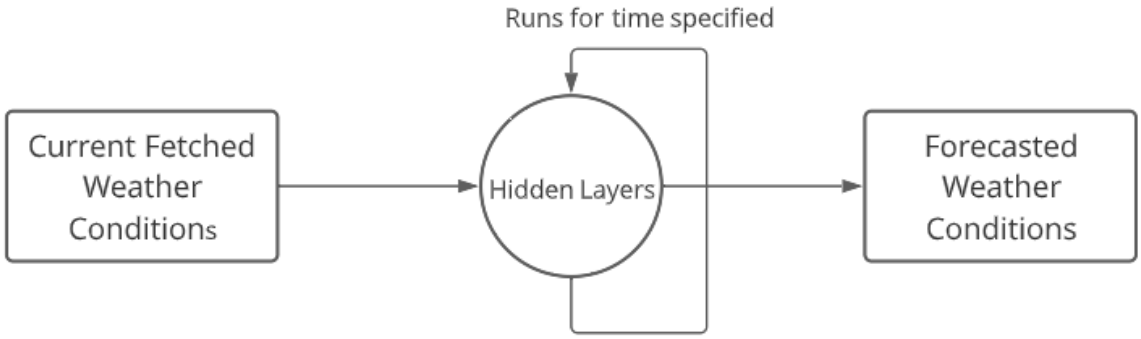

Fig 6.3.1 RNN

6.3.2 Random Forest Algorithm

The Random Forest Algorithm is based on ensemble learning, which is the act of integrating numerous classifiers to solve a complex problem and improve the model's performance. For the building of the crop classification model, the Random Forest Classifier Algorithm will be employed. Amongst all different classification algorithms that we tested, Random Forest Classifier gave the highest accuracy score of all and hence we have used this algorithm to train our crop classification model.

Input -

The outputs of the weather forecasting model and soil data fetched from the user are given as input to the crop classification model.

Output -

This crop classification algorithm gives a list of suitable crops to the given input weather conditions and soil composition.

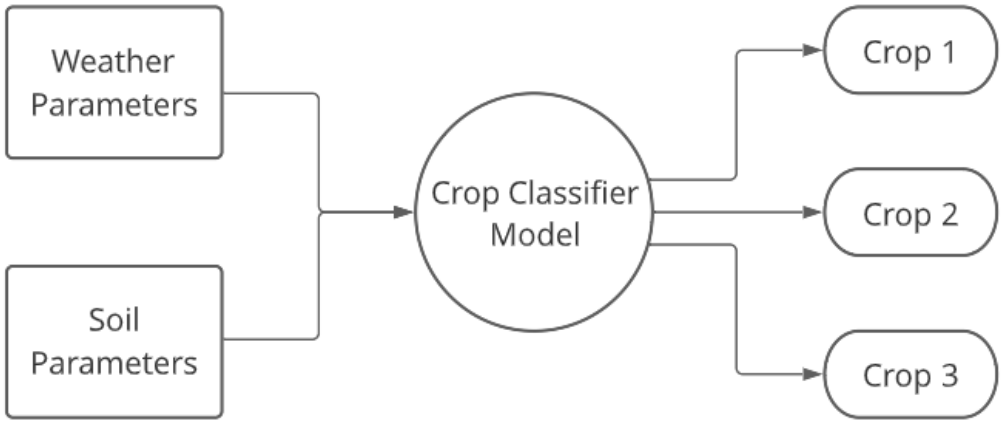

Fig 6.3.2 Random Forest Classifier

CHAPTER 07

SOFTWARE TESTING

7.1 TYPES OF TESTING

7.1.1 Unit Testing

Testing was done on various individual elements of the project including the Weather API, and various units of the Android Application. We had to make sure that each unit and Activity created with the application functioned as intended.

7.1.2 Integration Testing

Testings were done to see if the Weather API worked well with the Android Activity with which it was supposed to integrate. Login Module was thoroughly tested to see if it is able to access the intended databases correctly and fetch accurate information based on the fed SQL query.

The crop classification model was converted into appropriate file type to be able to integrate with the application and necessary testings were done.

7.1.3 Functional Testing

Each individual element's functionalities were tested under various scenarios to check if they function as intended. Testings were done to see if Weather API fetched accurate weather conditions based on input fed to it and that database worked as intended.

7.1.4 Stress Testing

Repeated LogIn and LogOut activities were conducted to see if they perform as intended in each case. Testings were conducted to see if the Weather API could fetch weather conditions under low internet connectivity situations. Various scenarios were tested to see if the application crashes or not. The application was also run in different Android versions to check relative performance.

7.1.5 Usability Testing

The GUI was shown to some non-team members and feedback was taken related to ease of usage of the application and suggested changes were made to make the UI more easy to use.

7.2 TEST CASES & TEST RESULTS

ID	Test Case	Expected Outcome	Produced Outcome	Result
101	Fetching weather data using Weather API	Fetch accurate current weather data	Fetched active weather data	PASS
102	App recognizes new versus registered user	Open modules based on new or old account	Open modules based on new or old account	PASS
103	RAM consumed by app	Low	Low	PASS
104	SQL Database Connectivity	Fetches accurate information based on query	Fetches accurate information based on query	PASS
105	LogOut Activity	Logs out current account successfully	Logs out current account successfully	PASS
106	Crop Prediction	Predicts appropriate crops based on input	Predicts appropriate crops based on input	PASS
107	Crop History	Saves history of crops predicted based on region and date accurately	Saves history of crops predicted based on region and date accurately	PASS

Table 7.2 Test Cases & Results

CHAPTER 08

RESULTS

8.1 OUTCOMES

Weather API -

Fetches accurate active weather conditions based on specified location with a latency depending upon the internet connectivity.

Crop Prediction -

Successfully trained model with dataset created using real life data collected from government websites. Model trained successfully using Random Forest Classifier with following outcomes -

- Accuracy = 91.04%
- Recall = 92%
- Precision = 92%

Android Application -

Works successfully without issues on all android devices with version 5 and above. UI is easy to use and all databases work as intended.

8.2 SCREENSHOTS

8.2.1 Login Module

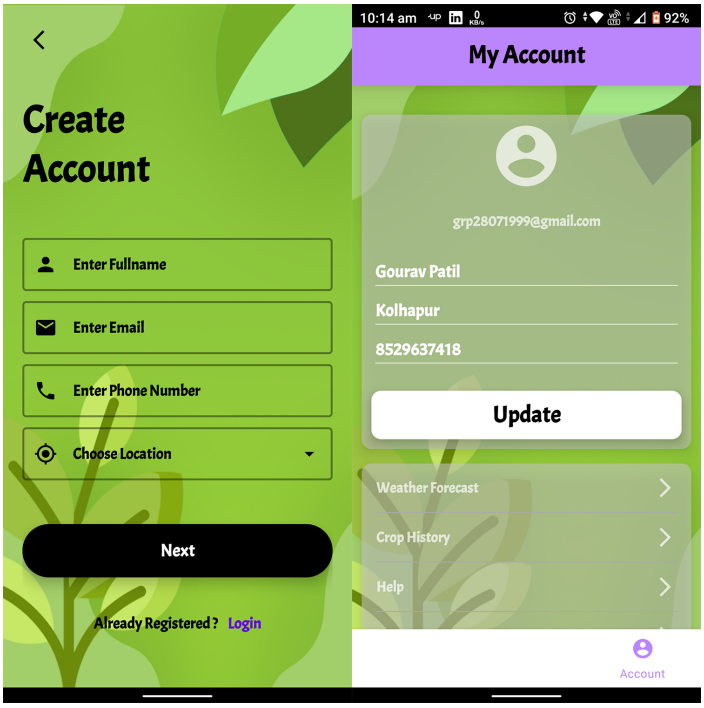

Fig 8.2.1 Login Module

8.2.2 Crop Prediction Module

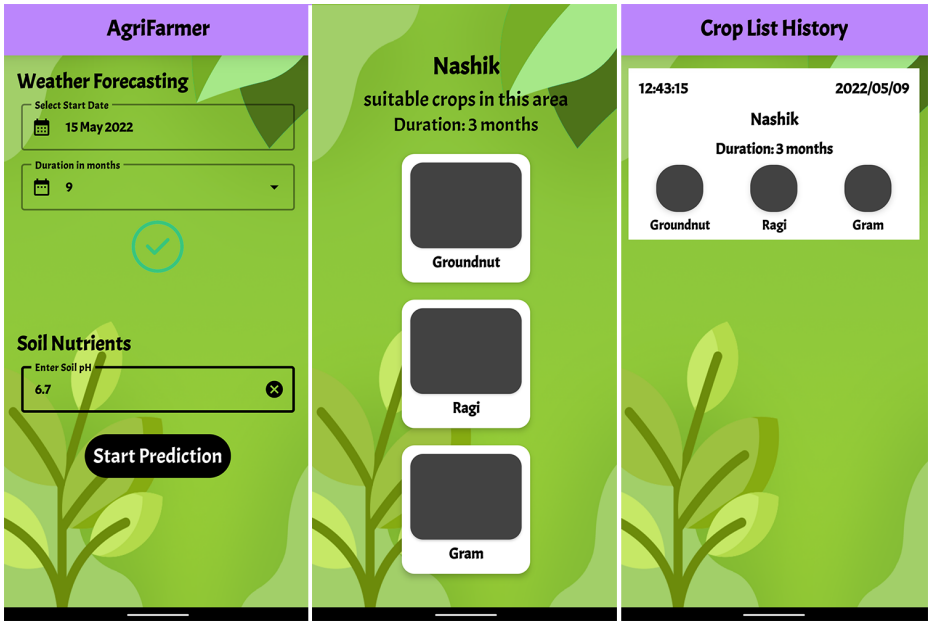

Fig 8.2.2 Crop Prediction Module

CHAPTER 09

CONCLUSION

9.1 CONCLUSION

Our crop prediction can thus help farmers plan ahead of time by sowing seeds of crops that will grow best in the given conditions hence increasing their yield and subsequent profit gained. With the help of an easy to use and user friendly application, farmers can get appropriate information about which crop to select.

Our Weather API will also help farmers gain an insight into future upcoming weather and they can plan accordingly.

9.2 FUTURE WORK

We will improve our model with more and more gathered data and expand the scope both in terms of crop variety as well as regions. Addition of more parameters to make the model more robust and keep it updated to coming needs.

Future work might involve including fruits as well into the model.

9.3 APPLICATIONS

The data that we gather from various users who will use the application can prove helpful to various related research and projects.

Get appropriate crops that will grow best in given soil and weather conditions.

APPENDIX A

Problem Statement feasibility assessment using, satisfiability analysis and NP Hard, NP Complete or P type using modern algebra and relevant mathematical models.

P - Solving in polynomial time. Problems that can be solved in polynomial time, such as O(n), O(n2), and O(n3).

NP - Unpredictability Solving in polynomial time. Problems that cannot be solved in polynomial time, but NP problems are checkable in polynomial time, which means that we can check whether a solution is correct or not in polynomial time.

NP Hard - If a problem is NP Hard, it indicates that I can reduce any NP problem to it. This implies that if I can solve that problem, I can solve any NP problem with ease. It would prove that P = NP if we could solve an NP Hard problem in polynomial time.

NP Complete - If a problem is both NP Hard and NP, it is called NP Complete.

Algorithms & Techniques

Algorithm 1: Recurrent Neural Networks (For Weather Forecasting)

Algorithm 2: Random Forest Classifier (For Crop Classification)

Time Complexity: The system will take some time for fetching current weather conditions according to user location through Weather API, also the system will take time to fetch the soil composition data from IoT Architecture.

Complexity Analysis:

Algorithm 1: O(number of hidden layers * number of weights) per time step

Algorithm 2: O(v * n log(n)), where v is the number of variables/attributes and n is the number of records.

Space Complexity: More the storage of data, the more is the space complexity. Each time we store resultant data in the database. So more space complexity.

APPENDIX B

Details of paper publication: name of the conference/journal, certificate.

Name of the conference: **3rd DOCTORAL SYMPOSIUM ON COMPUTATIONAL INTELLIGENCE (An International Conference)**

Certificates:

DoSCI-2022

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(An International Conference)

Certificate

This is to certify that **Prof. / Dr. / Mr. / Ms. Rajesh Lomte** is a presenter/ co-author of the paper titled **Cropping Pattern based on Weather Conditions and Soil Composition - A Survey** presented in the **3rd Doctoral Symposium on Computational Intelligence (DoSCI-2022)-An International Conference** organized by Institute of Engineering and Technology, a constituent college of Dr APJ Abdul Kalam Technical University Lucknow, India in association with University of Calabria, Italy on **05th March, 2022**.

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