A

PROJECT REPORT

FOR

SUBJECT: LAB II- PROJECT PHASE II

ON

‘BaliRaja’
A Crop Recommendation And Risk Alerting System

Submitted in partial fulfillment of the requirement for the award of

Bachelor of Engineering

In

Computer Science and Engineering

By

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Under the Guidance of

Mr. P. S. R. Patnaik

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
WALCHAND INSTITUTE OF TECHNOLOGY
SOLAPUR - 413006
(2019-2020)

Certificate

This is to certify that the project entitled

‘BaliRaja’
A Crop Recommendation And Risk Alerting System

Is submitted by

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Project Approval Sheet

The Project Entitled

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ACKNOWLEDGMENT

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Secondly, we would like to thank our Class Coordinator, Parents, and our friends who helped in finishing this project within a limited time.

UNDERTAKING

We solemnly declare that project work presented in the report titled **“BaliRaja” : A Crop Recommendation And Risk Alerting System** is solely my project work with no significant contribution from any other person except project guide Mr. P. S. R. Patnaik. Small contribution/help wherever taken has been duly acknowledged and that complete report has been written by the members of the project group.

We understand the zero-tolerance policy of the WIT, Solapur, and University towards plagiarism. Therefore we as Authors of the above-titled report declare that no portion of the report has been plagiarized and any material used as a reference is properly referred/cited.

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INDEX

1. ABSTRACT

India is a huge Agricultural Hub and more than 50% of the Indian workforce is involved in agriculture[1]. Yet, the economic contribution of agriculture to India's economy is not that significant. Today's agriculture is not the kind of farming as our ancestors did. In the present competitive environment, a farmer needs better education, expertise, and good knowledge of technologies and tools to be successful in agriculture. Farmers usually select crops for cultivation according to their traditional knowledge and past experiences in farming, but a farmer's predictions may go wrong due to natural disaster, inadequate rainfall, unexpected weather conditions, incomplete knowledge about soil testing results like NPK and pH values, Macro and Micronutrients, soil type, etc. The ever-changing climatic conditions due to factors like global warming have caused a difficulty to predict the climatic conditions which in turn affects crop production. High production, maximum profit, and healthy crops are the major issues in current farming practices.

Thus, to overcome the above issues, the main focus is on crop selection. crop with maximum profit and with minimum losses is to be selected. Farmers will be able to maximize the use of their land by planting the right crop in the right place and at the correct time of the year which will generate an improved yield. There are various factors like unexpected weather conditions, soil compatibility, pest/insect/disease attacks, irrigated/Non-Irrigated land, production of crops in local areas, and also the fluctuating rates of crops, etc. which decides the crop selection process. Thus, considering the above factors a proposed system named **"BaliRaja": A Crop Recommendation And Risk Alerting System** an Ensemble-based[15] crop recommendation machine learning model is developed. The ML model is divided into two parts, one is for irrigated land and another one is for Non-Irrigated land. Decisions on selecting a crop for cultivation can improve production and can acquire maximum profit.

This project is integrated with a mini project named **"Naradwani"** which is a risk alerting system. It sends alerts through SMS to the registered farmer's mobile number for recommended/registered crop, when favorable weather conditions occur for a pest/insect/disease outbreak. The risk alerting system fetches the weather forecast data from the weather API[7] up to a week's time in advance. The alert SMS is sent through SMS gateway[8] in a farmer's local language. The google translate is used for translating the alert messages in various languages on the backend.

"Baliraja" is a multilingual responsive web application. In this farmers are expected to give some inputs on the frontend which include farm location, Soil type, NPK values, and pH value, the approximate month of cultivation, Budget, and language for alerts, etc. This project is an integration of both crop recommendation and crop risk alert systems which is the biggest advantage over existing systems in the market.

2. INTRODUCTION

The agriculture field is the backbone of India. Agriculture supplies the food and raw materials to the people in the country. It is the only income source for many people. According to the latest report, agriculture is the primary source of livelihood for 58% population in India. Nearly 43% of India's Geographical area has been held by Agricultural sectors[1]. Basic food crops are produced using agriculture for decades. People who belong to the agriculture field face many problems such as decreasing production due to unsuitable climatic changes, floods, dearth, and many other natural reasons. Agriculture in India largely depends on monsoon. As a result, the production of food-grains fluctuates year after year. A year of abundant output of cereals is often followed by a year of acute shortage. This, in turn, leads to low income and employment fluctuations.

Agriculture today is not like our forefathers did. Climate change has caused difficulty to understand local climatic conditions. The impacts of climate change on agriculture in India has not only affected the practices of agriculture and the country's economy but also has major socioeconomic implications[3]. High production, maximum profit, and healthy crops are major issues in the current farming scenario.

So farmers are unable to understand which crop to cultivate that will improve the production rate and in-turn will increase profits. If there is more than one option to plant a crop at a time using limited land resources, the selection of crops is a puzzle. Farmers select crops by either using their traditional knowledge or by taking advice from other farmers in their region, but the farmer's prediction may go wrong due to factors like natural disasters, inadequate rainfall, unexpected weather conditions, incomplete knowledge about soil testing results like NPK and pH values, Macro and Micronutrients, soil type, etc. So, the selection of crops depends on various parameters such as climatic conditions, soil testing results (NPK and pH values), soil type, farmer's budget, farm location, irrigation type, cultivation period and cultivation time of the year, rates of crops and local production of crops.

So, the proposed project **"BaliRaja": A Crop Recommendation And Risk Alerting System** helps farmers to select the most profitable crop considering all mentioned factors. It is a responsive web application that recommends the crop with most minimum risks to farmers by using advanced machine learning algorithms. The majority of farmers don't have desktop machines or laptops. Even the farmers' mobiles have various types of operating systems. That's why this responsive web application is far better than desktop application and android application because it can be accessed from any machine. Also, as the majority of farmers only know their local language so this web application is made multilingual with more than 100 available languages. The web application has firebase phone number based OTP authentication[6] for the convenience of farmers so that they don't need to worry about remembering passwords.

Web application's primary work is farmer's registration, crop recommendation, and SMS alerts for cultivated crops based on farmer's input. Users are provided a dashboard for their login which shows a list of all crops recommended by the ML model or crops registered by the farmers for crop SMS alerts. Farmers can remove crops in case of multiple recommendations and only keep crops that need alerts. Even farmers can remove the crop if it's cultivation period is over. Also, a feedback form is provided when a farmer wants to remove any crop. This feedback form can be used for the improvement of the ML model in the future. The web application also provides visualization of the crops recommended nation/state/district wise using pie charts even if the user is not logged in. Farmers can use this chart if he gets multiple crop recommendations to understand crop distribution.

The ML model is trained on the dataset which recommends crops with most minimum risk. The ML model may give multiple crops as output. The system expects input from farmers on the system frontend. These inputs are encoded into JSON format and are passed to the flask web server by calling Flask API[18] using the cURL library. The flask web server decodes the JSON formatted data and passes it to the ML model. Now the ML model gives the output which is encoded into JSON and sent back the result. Now the result is decoded by PHP and is shown on the output page. Inputs and the recommended result stored in the database. The ML model is divided into two parts, one is for irrigated land and another one is for Non-Irrigated land. Irrigated land ML model is trained on a dataset[11], [12], [13] consisting of features that include soil type, NPK values, min and max pH values, the month of cultivation, and location. In the Irrigated land ML model, three algorithms are used under one meta learner of the stacking ensemble technique[15] (Total four Algorithms) instead of just relying on a single algorithm. In the Non-irrigated land ML model, the rule-based approach works, and the decision tree works as a backup algorithm. In the Non-Irrigated ML model, the rainfall dataset[13] is generated using the Regression algorithm as input to the ML model. The Non-irrigated land ML model is trained on features that include the duration of cultivation, month of cultivation, min and max pH, NPK values of soil, min and max rainfall, and agro-climatic location.

For farmers, crop diseases are the biggest risk for bad yields besides bad climatic conditions. Farmers already have a small income, but if the bad yield is obtained then it can be really devastating and even life-threatening for them. So, this project is integrated with the Mini project named **"Naradwani"** which is a risk alerting system. It sends SMS alerts to farmer's mobile numbers for registered crops when favorable conditions occur for a pest/insect/disease outbreak so that they can apply an appropriate treatment in time. The risk alerting system fetches district wise weather forecast for the future 5 days from OpenWeather API[7] which includes temperature, humidity, and weather description. Average temperature and humidity of 5 days are considered and are checked if these values fall between the min-max temperature and min-max humidity range in the CSV file. This CSV file contains all the disease names which affect crops with their temperature and humidity range and treatment respectively. Now, if the value falls between the range, all the farmers that are registered for that crop are alerted for the potential pest/insect/disease outbreak. The SMS alert also contains the treatment information for the outbreak. The SMS alerts are sent to the farmers in their selected local languages. The google translator library is used in the backend for translating the SMS to different languages. FAST2SMS gateway[8] is used for sending SMS in bulk to farmers' registered mobile numbers. As a result, farmers will have a higher and more consistent yield and thus a better income.

The technologies used for the system are as follows:

2.1. Front End:

2.1.1. HTML: HTML stands for HyperText Markup Language. HTML is the standard markup language for creating Web pages. The project frontend is done by using HTML. It consists of a series of elements. HTML elements that tell the browser how to display the content.

Version: 5

License: W3C Software License

2.1.2. CSS: Cascading Style Sheets, fondly referred to as CSS, is a simple design language intended to simplify the process of making web pages presentable.

CSS handles the look and feel part of a web page. Using CSS, you can control the color of the text, the style of fonts, the spacing between paragraphs, how columns are sized and laid out, what background images or colors are used, layout designs, variations in display for different devices and screen sizes as well as a variety of other effects.

Version: 3

License: W3C Software License

2.1.3. Javascript & jQuery: JavaScript is the programming language of HTML and the Web. We have used javaScript for validating forms, adding google translate plugin, to use firebase phone no authentication[6], Hiding form elements, showing alert messages, and for visualization of the pie chart.

jQuery is a cross-platform JavaScript library designed to simplify the client-side scripting of HTML. jQuery is used for dependent dropdown.

Javascript version: 1.8. 5

jQuery version: 3.5.1

License: MIT License

2.1.4. Bootstrap: Bootstrap is a free and open source front end library for designing websites and web applications. It contains HTML and CSS based design templates for typography, fonts, buttons navigation and other interface components, as well as optional JavaScript extensions. We have used bootstrap to create a mobile responsive web application.

Bootstrap version: v4.5.2

License: MIT License

2.1.5. Google Translate Plugin: Google translate plugin is used to translate the website pages in other languages.

Version: 2.0.9

License: Wordnet, CC-BY-SA 3 License, GPL 3 License, MIT License, CC-BY 4.0 License, CeCILL-C License, CC-BY 3.0 License

2.1.6. Google Pie Chart: Pie charts are good for showing simple proportional part-to-whole information. One can create a single series pie chart, where each series is made of multiple slices, or multi-series, concentric charts.

In this project, the 3-dimensional pie chart is used to show the registered and recommended crops for a specified nation/state/district. Each crop specifies one slice. Crop name associated with slice displayed as a pie chart label. Crop names around the chart with lines pointing toward the slice.

Version: Frozen Charts Version 49

License: Creative Commons Attribution 4.0 License, Apache 2.0 License

2.2. Database:

2.2.1. MySQL: MySQL is a relational database management system based on **SQL** – **S**tructured **Q**uery **L**anguage. The application is used for a wide range of purposes, including data warehousing, e-commerce, and logging applications. The most common use for MySQL however, is for the purpose of a web database. It can be used to store anything from a single record of information to an entire inventory of available products for an online store.

Version: 8.0.21

License: GNU Public License

2.2.2. Firebase: Firebase is a mobile- and web application development platform, backed by Google, to help developers deliver richer app experiences. Firebase manages its own infrastructure with a nice set of tools to simplify the workflow of the developer by providing them with development kits and an online dashboard. These toolkits are interconnected, scalable and integrable with third party software to overcome complex challenges with standard building blocks. Firebase is used for phone number based authentication purposes by OTP[6].

Version: 4.0.0

License: Creative Commons Attribution 4.0 License, Apache 2.0 License

2.3. Back End:

2.3.1. PHP: PHP (recursive acronym for *PHP: Hypertext Preprocessor*) is a widely-used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML. PHP is used in this project to maintain user sessions and cookies for login. Also, it is used to perform CRUD operations.

Version: 7.4.8

License: PHP License v3.01

2.3.2. Flask: Flask is a micro web framework written in Python. Flask is used to create a Flask API that allows to send data from the frontend to the ML model and receive the prediction data as a response by the ML model[18].

To integrate the ML model into the website the Flask API is used. Whenever API is called, it first loads the pickle file. Once the file is loaded ML model starts making predictions. Predictions are made by passing POST JSON requests to the Flask web server. In app.py the request is received and prediction is done based on an already loaded model. It returns the prediction in JSON format.

Version: 1.1.2

License: BSD License

2.3.3. Python: Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. Python is used for the Alert module and also it played an essential role in training the ML model by using various built-in libraries. Python comes with various advanced features that help to code efficiently and also help to deal with APIs and Libraries eg. FAST2SMS[8] and OpenWeather APIs[7] and libraries like googletrans, requests, time, CSV, DateTime, schedule etc.

Version: 3.8.5

License: Python Software Foundation License (PSFL)

2.3.4. Weather API: The OpenWeather API service provides a 3-hour step Weather Forecast for the next 5 days which consists of various weather parameters but for this project, one can use temperature, humidity, weather condition, and rainfall situation[7].

License: CC BY-SA 4.0 License, Open Data Commons Open Database License (ODbL).

2.3.5. FAST2SMS: Fast2SMS is a popular bulk SMS service provider in India, famous for its performance-driven messaging services. FAST2SMS API is used in this project to send the translated risk alerts to registered farmers' mobile numbers through SMS gateway[8].

License: Proprietary License

2.3.6. Cron jobs: The software utility Cron is a time-based job scheduler in Unix-like computer operating systems. Users that set up and maintain software environments use cron to schedule jobs to run periodically at fixed times, dates, or intervals[9].

Version: 0.6.0

License: MIT License

2.4. Machine Learning:

2.4.1. Ensemble learning: In statistics and machine learning, the ensemble method uses multiple learning algorithms to obtain better predictive performance over one meta-learning algorithm[15]. Bagging or Boosting methods can be used for this but the Stacking method generates better results on the project dataset[14]. So, the project consists of a Stacking ensemble method in irrigated land ML model which gives better results than any of the single algorithms.

Version: 0.23.2

License: OSI Approved (new BSD) License

2.4.2. Numpy: It is a well known general-purpose array-processing package. An extensive collection of high complexity mathematical functions make NumPy powerful to process large multi-dimensional arrays and matrices. NumPy is very useful for handling linear algebra, Fourier transforms, and random numbers.

Version: 1.19.1

License: OSI Approved (BSD) License

2.4.3. Pandas: Pandas is a fast, powerful, flexible and easy to use open source data analysis and manipulation tool built on top of the Python programming language.

Version: 1.1.0

License: BSD

2.4.4. Pickle*:* The pickle module implements a fundamental, but powerful algorithm for serializing and de-serializing a Python object structure. Pickle operation is to serialize the machine learning model and save the serialized format to a file and later can load this file to deserialize the model and use it to make new predictions.

2.4.5. Scikit-learn: Scikit-learn is probably the most useful library for machine learning in Python. The sklearn library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction. Scikit-learn is largely written in Python and uses NumPy extensively for high-performance linear algebra and array operations. It has minimal dependencies and is sent beneath the simplified BSD license, encouraging its use in each educational and commercial settings. Scikit-research differs from other machine learning toolboxes in Python for numerous reasons as an instance underneath the BSD license. Scikit-examine is distributed and it consists of compiled code for more efficiency.

Version: 0.23.2

License: OSI Approved (new BSD) License

2.4.6. Matplotlib: **Matplotlib** is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK+. There is also a procedural "pylab" interface based on a state machine (like OpenGL), designed to closely resemble that of MATLAB, though its use is discouraged. SciPy makes use of Matplotlib.

Version: 3.3.1

License: Python Software Foundation License (PSF)

3. EXISTING SYSTEMS

3.1. System For Agriculture Recommendation Using Data Mining:

In Dec 2015 "System For Agriculture Recommendation Using Data Mining"[2] was proposed by Nilesh Dumbre, Omkar Chikane, and Gitesh More which was published in the International Education and Research Journal IERJ Issue 1 Volume 5.

This research paper mainly focused on Data mining techniques, which identifies the patterns using association rules from the huge datasets and uses genetic algorithms on those patterns to recommend the crop. In this project, a system is presented that can be used to decide the suitable crop for sowing. This web-based system extracts the required result from the web. The system is using the Weather Forecast Report, Soil and Land use survey of India, Soil Report survey, crop survey as databases. The system will be extracting databases for crop selection when the farmer is required and sends that data firstly to the user's computer and then the message to the farmer. The system will be mining the suitable crop for a particular farm of a farmer and generates results in user compatible format. The system will send SMS ALERTS alerts to the farmer about the crops suitable for the farm based on the mining result. It may contain one or more crops for selection but the priority is given to only that crop which is more suitable. So he can sow or plant these crops without worrying about the production of crops in the field or climatic changes.

The above system uses genetic algorithms, association rules, and Knowledge Discovery in Databases(KDD) which take a long time to find patterns in a huge database and the developer has to change his approach if the database gets changed or fixed patterns are changed, unlike machine learning. So rather than predicting the actual crop, it finds a pattern in the database and generates a pattern that may output the wrong result. Also, this project doesn't consider rainfall data so it may not consider dryland crops that are fully dependable on rain for its growth. As rainfall data is not considered in this system the crop selection may severely go wrong and lead to loss of farmer resources. It only sends SMS of crop selection to the farmer so it is not SMS alert. This project's web-based system and crop selection SMS alerts don't have a multilingual facility. As the majority of farmers know only local languages they may not be able to read this, so it's a major drawback of this system. This web-based system is only a crop recommendation system; it does not consider post-cultivation problems like pest/insect/disease attacks and does not send any alerts to protect the crops from these risks and precautions to overcome those attacks.

3.2. Agricultural Recommender Using Data Mining Techniques:

In April 2015 "Agricultural Recommender Using Data Mining Techniques"[3] was proposed by Mr.Omkar B. Bhalerao and Prof. L. M. R. J. Lobo. To get an optimized result from various agricultural databases by applying the data mining and optimizing techniques and understanding the soil condition and giving the proper recommendation of the crop on the basis of soil condition and other factors. It also recommends the use of fertilizers and pesticides for a specifically recommended crop. With respect to this recommendation, they also suggest side business for farmers which will be helpful to improve his economic life.

The proposed methodology is a two-stage model. In the first stage, they apply association rule mining on the agriculture historical data and generate rules from frequent itemsets by applying the proper support and confidence for each rule. The user then gives minimum support and confidence and based on these initial best rules that form the initial population for GA is extracted. In the second stage, they applied a Genetic algorithm to optimize the initial population rules which they got from association rule mining. So that they will get the best rules that predict output as an optimized agriculture crop.

The recommendation considers very few factors so it's difficult for the system to generate appropriate rules for the recommendation. Even the location of the farm, land type is not considered so it's not that much robust to predict accurately. It also has fewer numbers of crops to predict. As it is a two-stage system, the second stage uses a genetic algorithm that takes a long time to produce results. Once the crop is recommended there is no follow up of the crop like sending alerts in case of pest attacks. It is only a recommendation system that does not include a risk alert system. The System doesn't show state/district wise distribution of crop cultivation/recommendation. The system is not multilingual and it only considers Emulsifiable Concentrate (EC value) for informing about the use of fertilizer for recommended crops.

3.3. Crop Recommendation System For Precision Agriculture:

Another research paper "Crop Recommendation System for Precision Agriculture"[4] published in 2016 IEEE Eighth International Conference on Advanced Computing (ICoAC) by S.Pudumalar*, E.Ramanujam*, R.Harine Rajashreeń, C.Kavyań, T.Kiruthikań, J.Nishań.

Precision agriculture is a modern farming technique that uses research data of soil characteristics, soil types, crop yield data collection, and suggests the farmers the right crop based on their site-specific parameters. This reduces the wrong choice on a crop and an increase in productivity. In this paper, this problem is solved by proposing a recommendation system through an ensemble model with the majority voting technique using Random tree, CHAID, K-Nearest Neighbor, and Naive Bayes as learners to recommend a crop for the site-specific parameters with high accuracy and efficiency.

The data is collected for the Madurai district at the soil testing lab and only 10 crops are considered. The scope of this project is limited as data is limited to only one district. This recommendation system considers various soil testing result parameters like depth, soil color, pH, texture, water holding capacity, erosion, etc. So this recommendation system gives a crop recommendation based only on soil testing results but it does not consider other major factors like the weather forecast, rainfall, budget of the farmer, cultivation month, etc. This web-based system is only a crop recommendation system; it does not consider post-cultivation problems like pest/insect/disease attacks and does not send any alerts to protect the crops from these risks and precautions to overcome those attacks. It is not a multilingual system. As the majority of farmers know only local languages they may not be able to use this.

3.4. Crop Selection Method Based on Various Environmental Factors Using Machine Learning:

In Feb 2017 a research paper named "Crop Selection Method Based on Various Environmental Factors Using Machine Learning"[5] was proposed by Nishit Jain, Amit Kumar, Sahil Garud, Vishal Pradhan, Prajakta Kulkarni in International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 02.

The system uses machine learning to make predictions of the crop and Java as the programming language since Java has been the widely accepted language for experimenting in the machine learning area.

The proposed methods are i. Crop Selection Method ii. Crop Sequencing Method. The price factor is one of the most important factors which play a major role in selecting crops. For example, there are two crops and both produce equal yield but one crop is valued at a lower price than the other. If the price factor is not included in the crop selection method, then the system may lead to selecting the wrong crop to grow. Therefore, price is as important as factors such as soil type, rainfall, temperature, etc.

The crop selection method refers to a method of selecting crop(s) over a specific season depending upon various environmental as well as economic factors for the maximum benefit. These factors are precipitation levels, average temperature, soil type, market prices, and demand, etc. This task can be completed using the Classification algorithms of WEKA. The most important thing which is very essential for accurate results is feature selection. The Crop Sequencing Method uses a crop sequencing algorithm to suggest the sequence more concise the datasets are, the better will be the predictions of the crop(s) on the basis of yield rate and market prices. Prices of the crops are solemnly dependent upon the yield rates of the crops. Therefore, the Price of the crop is one of the most important factors in suggesting the crop sequence depending upon the market prices. As this system contains a crop sequencing method it suggests the sequence of crops on the basis of yield rate and market prices which acts as an advantage over all other systems.

It is not a multilingual system. This web-based system is only a crop recommendation system; it does not consider post-cultivation problems like pest/insect/disease attacks and does not send any alerts to protect the crops from these risks and precautions to overcome those attacks. As the majority of farmers know only local languages they may not be able to read this, so it's a major drawback of this system.

4. METHODOLOGY

4.1. System Architecture:

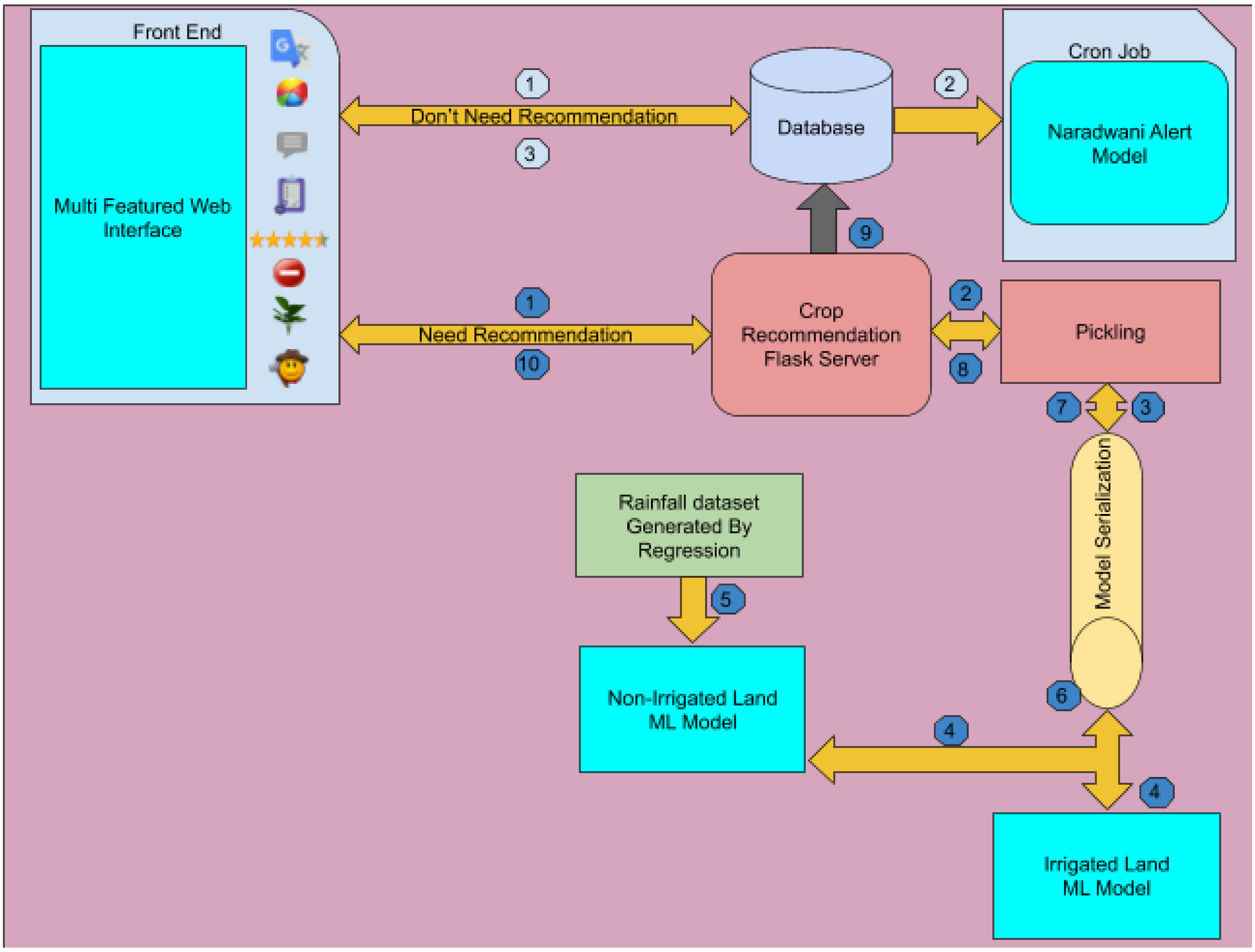

Front End
Multi Featured Web Interface
1
Don't Need Recommendation
3
Database
2
Cron Job
Naradwani Alert Model
9
1
Need Recommendation
10
Crop Recommendation Flask Server
2
8
Pickling
7
3
Model Serialization
Rainfall dataset Generated By Regression
5
Non-Irrigated Land ML Model
6
4
4
Irrigated Land ML Model

Fig 4.1. System Architecture

4.1.1. Front End:

Baliraja is a multilingual responsive web application with more than 100 available languages. This web application can be translated to any language as per farmer's requirements. When a farmer visits the website for crop recommendation or to receive crop alerts he/she has to authenticate his/her mobile number by the OTP-based system. An OTP (One-Time Password), is a password that is valid for only one login session or transaction, on a computer system or other digital device. An application Verifier object (reCAPTCHA) is included as an additional security measure to verify that the user is real and not a bot and to avoid denial of service attack. This mobile number authentication is done by using Firebase Authentication to sign-in/sign-up a user by sending an SMS message to the user's phone[6]. The user signs in using a mobile number and a one-time code contained in the SMS message.

The mobile number that the farmer authenticates in the previous step is used as a farmer’s mobile number and is checked if the mobile number exists in the database. If the mobile number already exists then a dashboard is displayed that shows previously registered crops for alerts or crops recommended by the ML model. Also, a “Register for a new Crop” Button is provided to register new crops for crop alerts or to get crop recommendations. If the farmer is not registered on the website he will be redirected to the registration form which expects farmer name, state, district, and language. Farmers can remove crops in case of multiple recommendations or if it’s cultivation period is over.

Now the farmer has to select one option among crop recommendations along with alerts or only alerts for cultivated crops. If he chooses ‘YES’ he has to fill the form that includes cultivation month, Soil testing results(N, P, K, min-pH, max-pH), Irrigation type, Soil type, Budget/Hectare, Land area in hectares. If he chooses ‘ NO’ he has to fill the same details but with one additional input crop name which will send risk SMS alerts for that Crop.

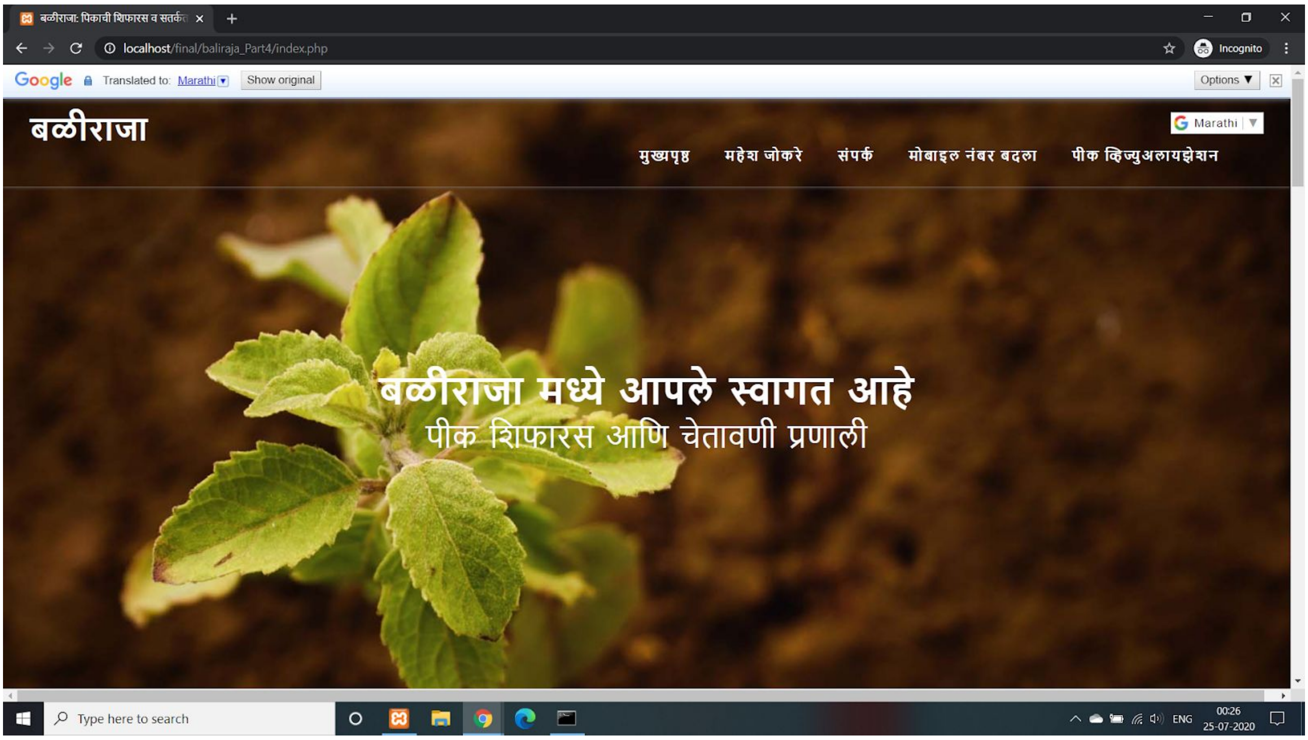
Also, a feedback form along with a rating is provided when a farmer wants to remove any crop. This feedback form can be used for the improvement of the ML model in the future. The web application also provides visualization for the crops recommended nation/state/district wise. Farmers can use this chart to make appropriate decisions and to understand crop distribution in the local region even without logging in to the system.

A farmer can also change his registered mobile number. When a user enters his new mobile number, the program will check if that mobile number already exists in the database, and if it does then the update gets failed. After failure, the user will get an alert message saying “Mobile number already exists” and for more information, a link to contact us page is provided in the alert box. If the mobile number is the same as the current mobile number he will get an alert “Old mobile number and new mobile number can’t be the same” and in this case, also the update gets failed. In all other cases, the farmer’s mobile number gets updated.

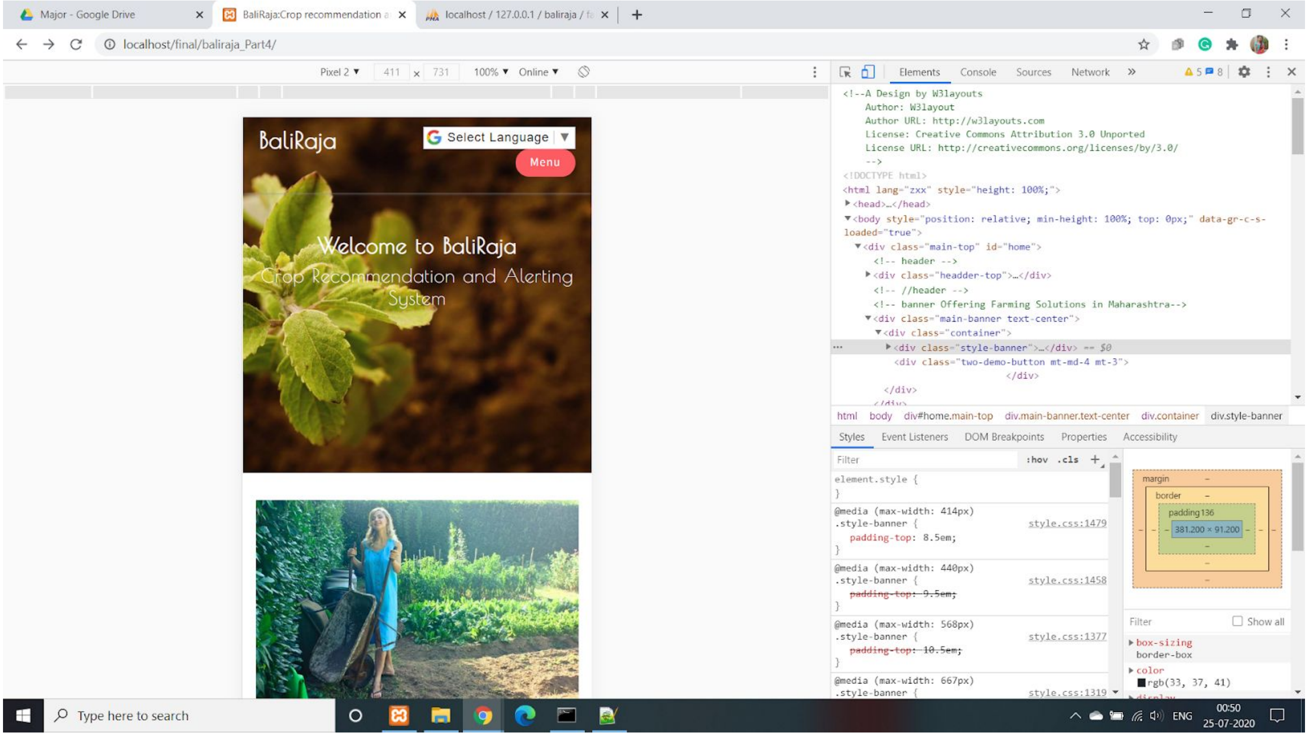
Javascript form validation is used for all the fields on the frontend. If a farmer faces any difficulties or has any queries he can contact experts/developers through the contact us page. The homepage gives information about this project and also tells the important features of this system.

Cookies are small files that are stored on a user’s computer to maintain the user's login. In case of a system crash, the web application remembers user login and lets you view the web application with your login. Users may have their login active till 5 days and after this time users will automatically get logged out. A session is temporary storage at a web server. For each user who is interacting with the web application, their form data is stored in session variables to use it on further pages.

4.1.1.1. Baliraja- Multilingual Web Application:



4.1.1.2. Baliraja- Responsive Web Application:

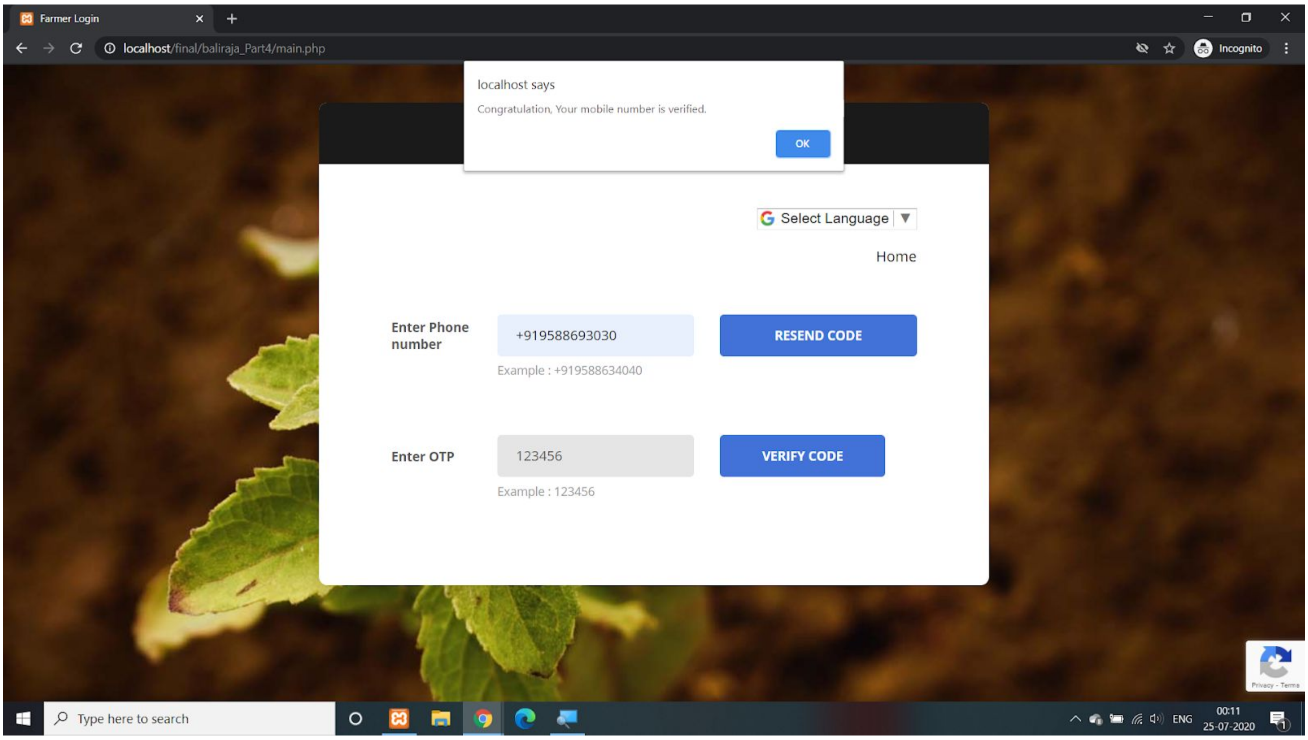


```
<!--A Design by W3layouts
    Author: W3layout
    Author URL: http://w3layouts.com
    License: Creative Commons Attribution 3.0 Unported
    License URL: http://creativecommons.org/licenses/by/3.0/
    -->
<!DOCTYPE html>
<html lang="zxx" style="height: 100%;">
▶<head>…</head>
▼<body style="position: relative; min-height: 100%; top: 0px;" data-gr-c-s-loaded="true">
  ▼<div class="main-top" id="home">
     <!-- header -->
    ▶<div class="headder-top">…</div>
     <!-- //header -->
     <!-- banner Offering Farming Solutions in Maharashtra-->
    ▼<div class="main-banner text-center">
      ▼<div class="container">
        ▶<div class="style-banner">…</div> == $0
         <div class="two-demo-button mt-md-4 mt-3">
                             </div>
       </div>
```

```
element.style {
}
@media (max-width: 414px)
.style-banner {                          style.css:1479
   padding-top: 8.5em;
}
@media (max-width: 440px)
.style-banner {                          style.css:1458
   ~~padding-top: 9.5em;~~
}
@media (max-width: 568px)
.style-banner {                          style.css:1377
   ~~padding-top: 10.5em;~~
}
@media (max-width: 667px)
.style-banner {                          style.css:1319
```

```
box-sizing
  border-box
color
  ■rgb(33, 37, 41)
```

4.1.1.3. OTP-based Mobile number verification:



Farmer Login

localhost/final/baliraja_Part4/main.php

localhost says

Congratulation, Your mobile number is verified.

OK

Select Language ▼

Home

Enter Phone number: +919588693030

RESEND CODE

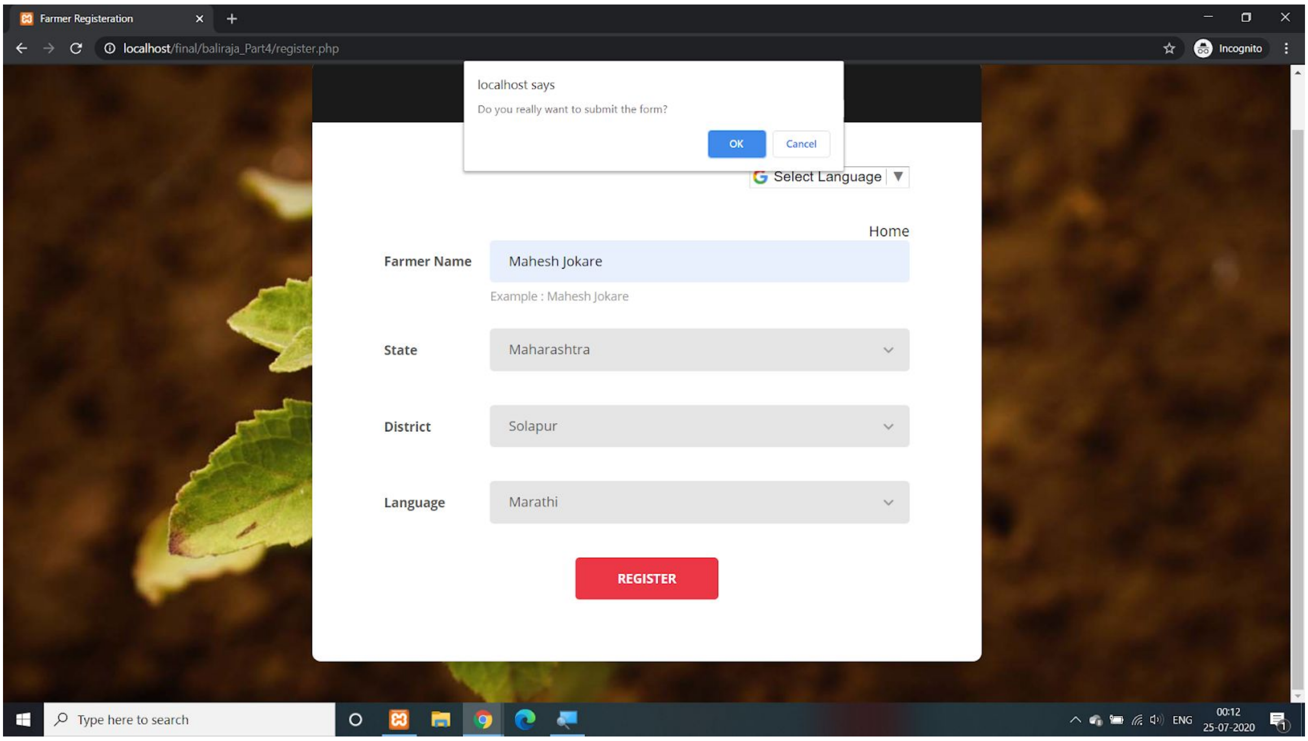
Example : +919588634040

Enter OTP: 123456

VERIFY CODE

Example : 123456

4.1.1.4. Farmer Registration Form:



Farmer Registeration

localhost/final/baliraja_Part4/register.php

localhost says

Do you really want to submit the form?

OK Cancel

Select Language ▼

Home

Farmer Name: Mahesh Jokare

Example : Mahesh Jokare

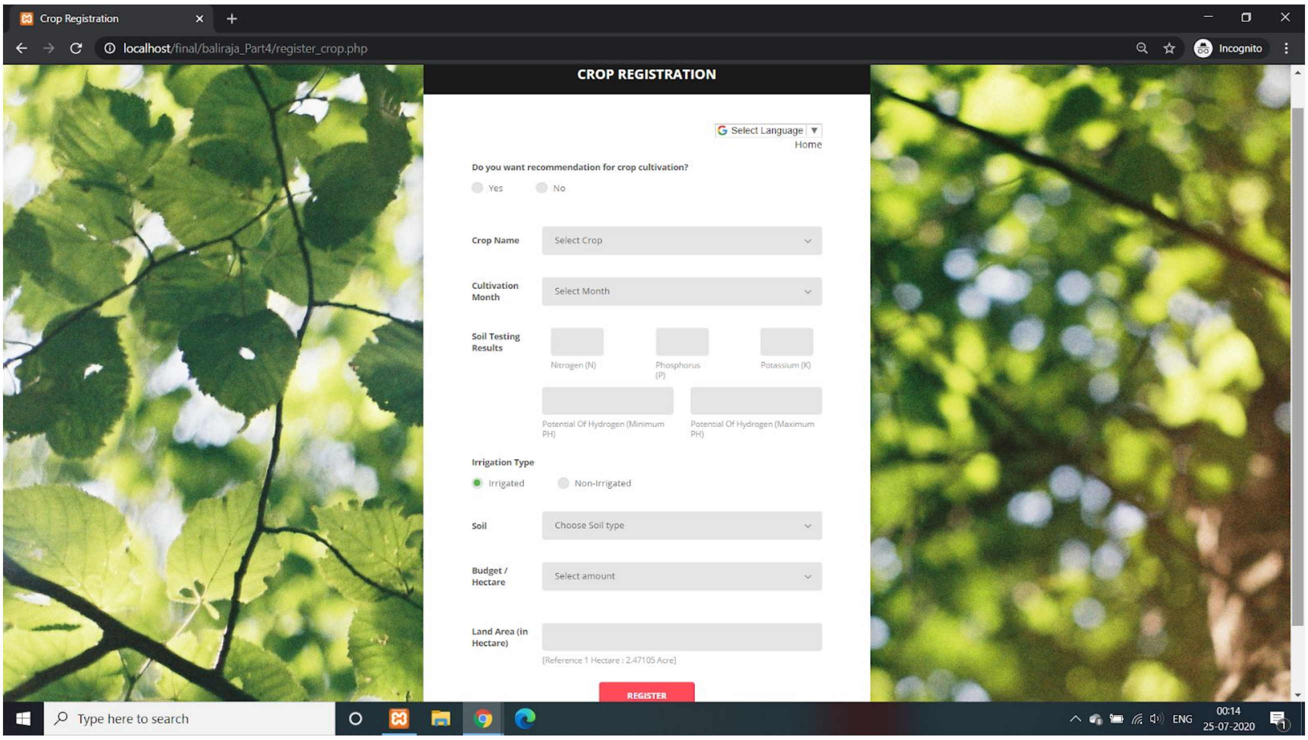
State: Maharashtra

District: Solapur

Language: Marathi

REGISTER

4.1.1.5. Crop Registration Form:



CROP REGISTRATION

Select Language ▼

Home

Do you want recommendation for crop cultivation?

○ Yes ○ No

Crop Name: Select Crop

Cultivation Month: Select Month

Soil Testing Results: Nitrogen (N) | Phosphorus (P) | Potassium (K)

Potential Of Hydrogen (Minimum PH) | Potential Of Hydrogen (Maximum PH)

Irrigation Type

● Irrigated ○ Non-Irrigated

Soil: Choose Soil type

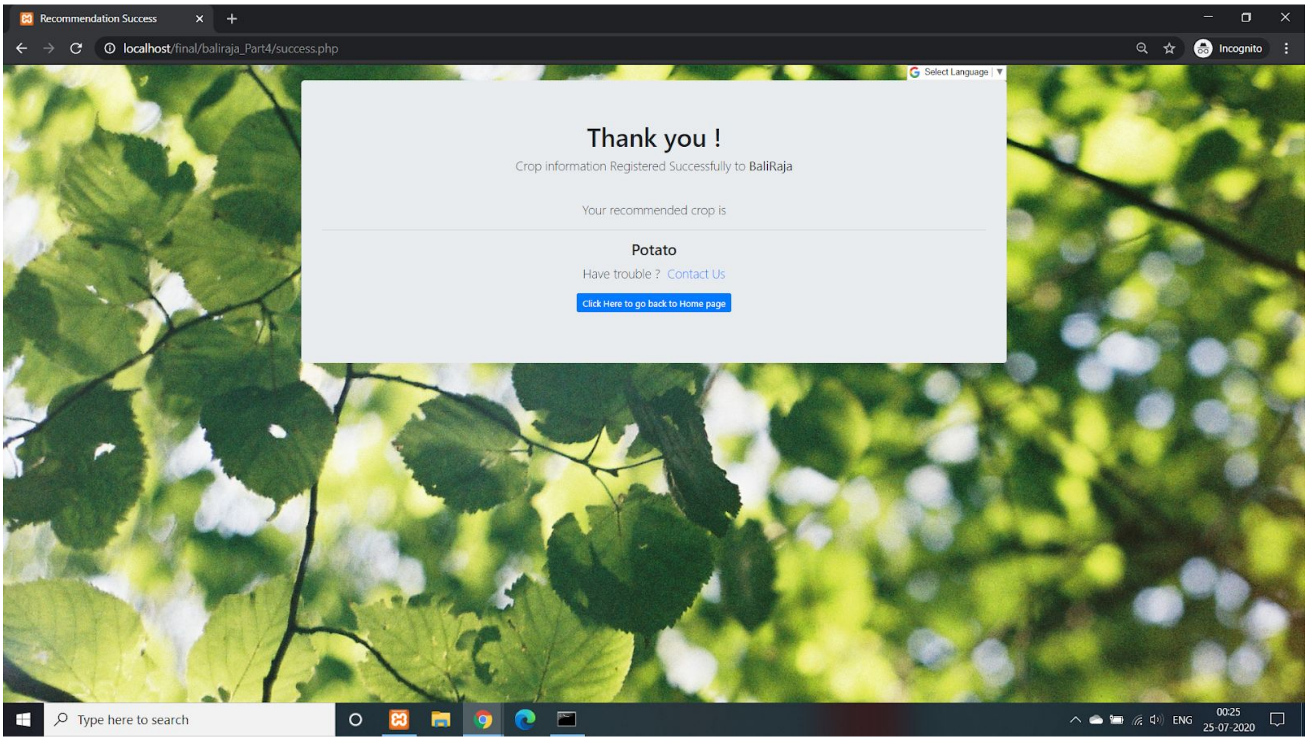
Budget / Hectare: Select amount

Land Area (in Hectare)

[Reference 1 Hectare : 2.47105 Acre]

REGISTER

4.1.1.6. Crop Recommendation:



Thank you !

Crop information Registered Successfully to BaliRaja

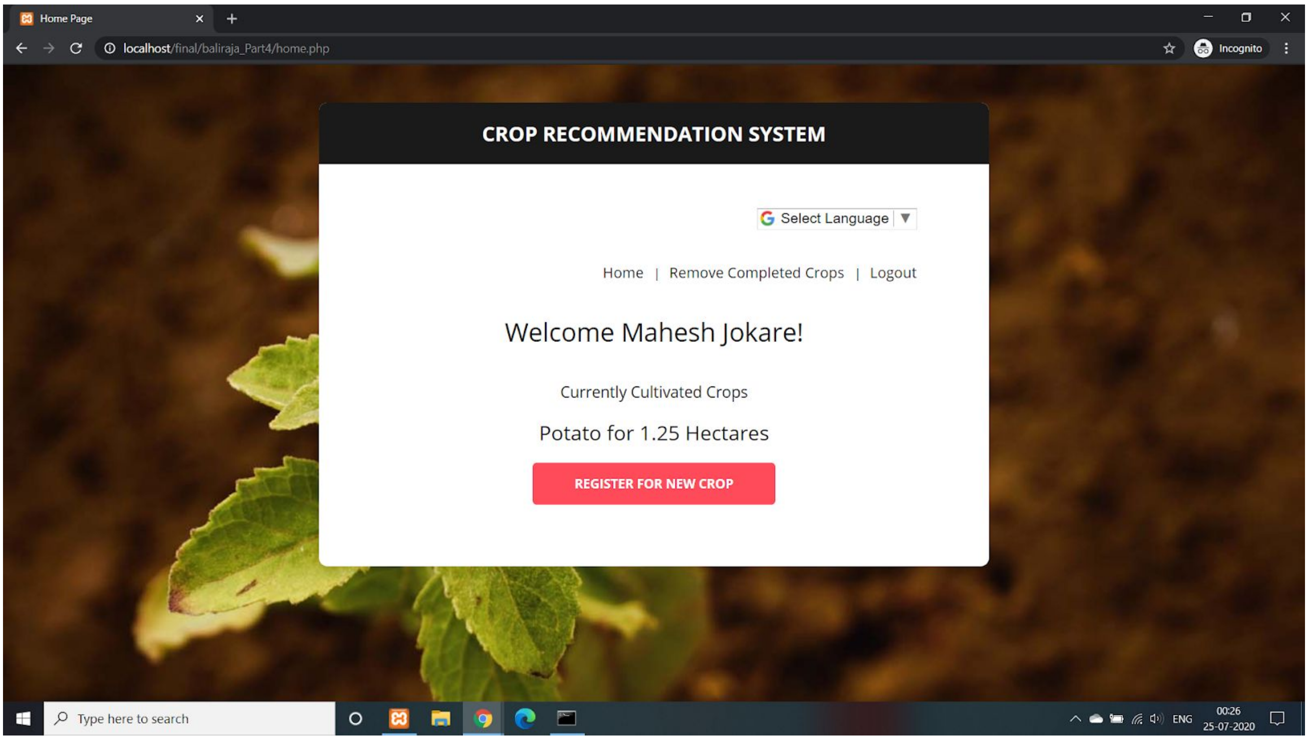
Your recommended crop is

Potato

Have trouble ? Contact Us

Click Here to go back to Home page

4.1.1.7. Farmers' Dashboard:



CROP RECOMMENDATION SYSTEM

Select Language ▼

Home | Remove Completed Crops | Logout

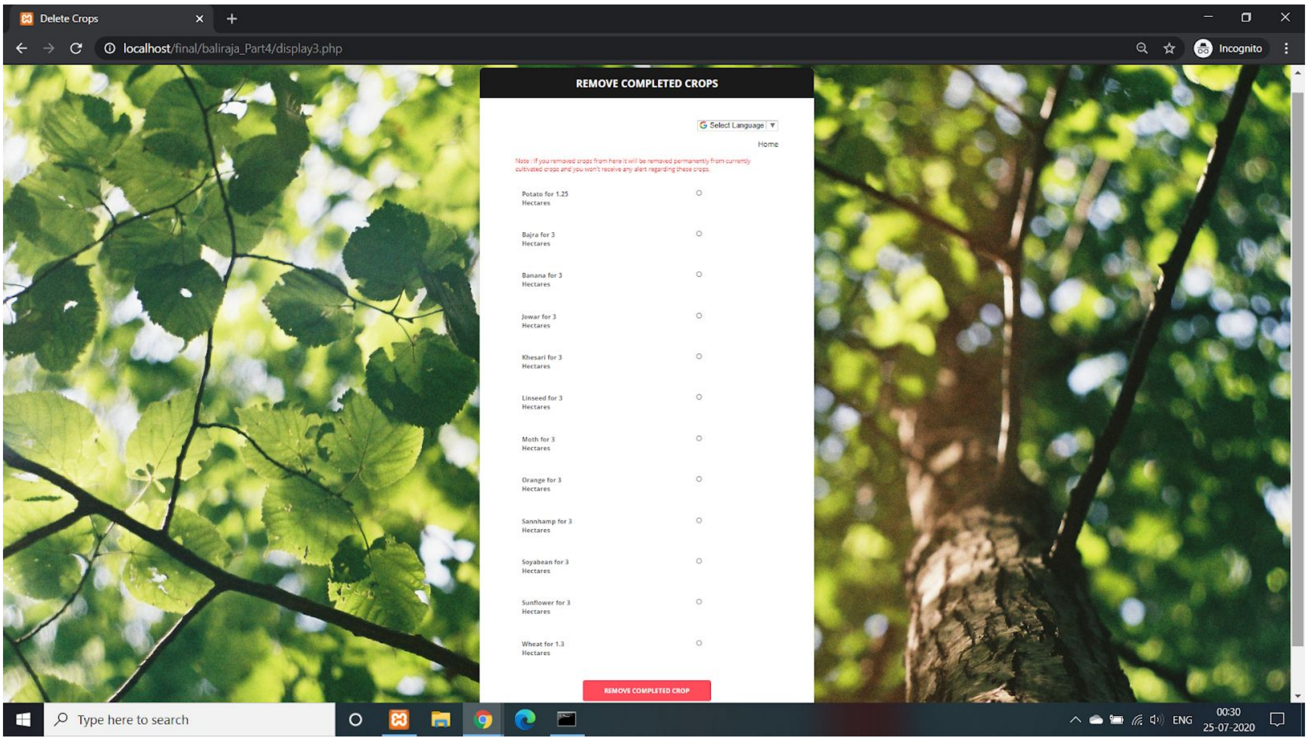
Welcome Mahesh Jokare!

Currently Cultivated Crops

Potato for 1.25 Hectares

REGISTER FOR NEW CROP

4.1.1.8. Removing Completed Crops:



REMOVE COMPLETED CROPS

Select Language ▼

Home

Note : If you removed crops from here it will be removed permanently from currently cultivated crops and you won't receive any alert regarding these crops.

Potato for 1.25 Hectares ○

Bajra for 3 Hectares ○

Banana for 3 Hectares ○

Jowar for 3 Hectares ○

Khesari for 3 Hectares ○

Linseed for 3 Hectares ○

Moth for 3 Hectares ○

Orange for 3 Hectares ○

Sannhamp for 3 Hectares ○

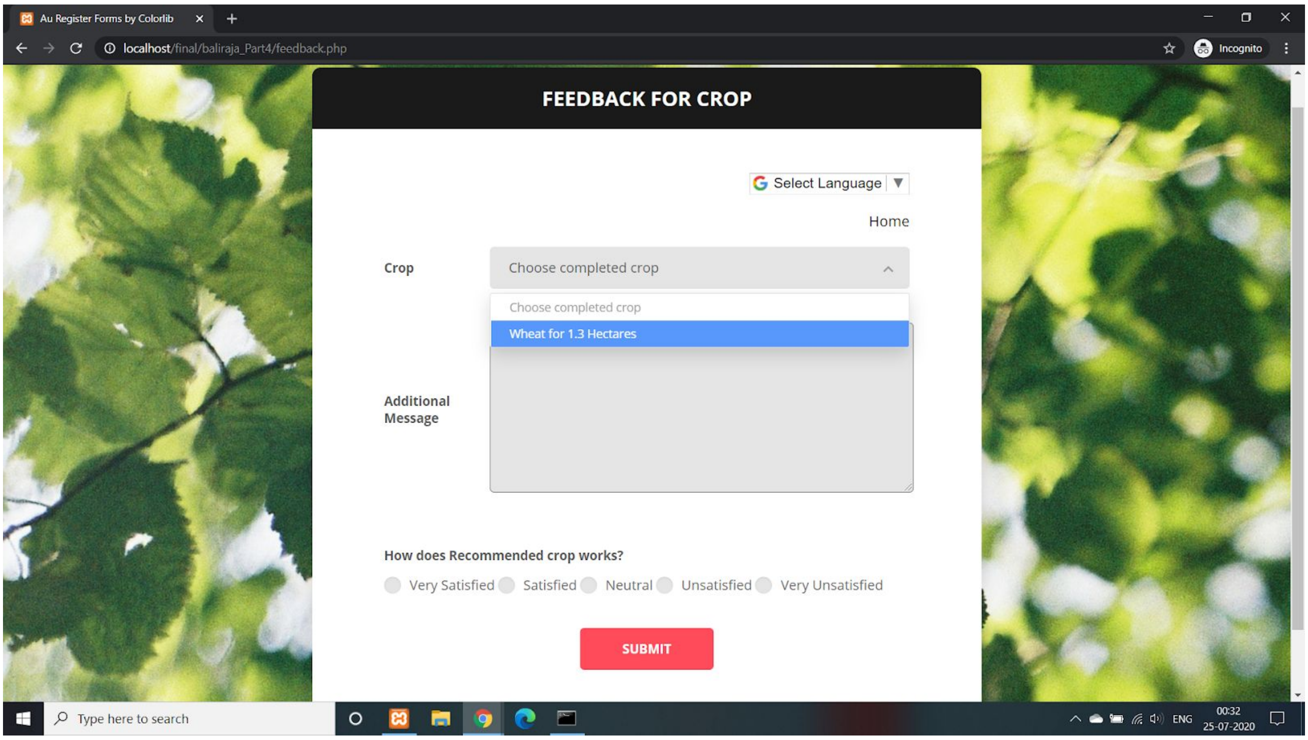
Soyabean for 3 Hectares ○

Sunflower for 3 Hectares ○

Wheat for 1.3 Hectares ○

REMOVE COMPLETED CROP

4.1.1.9. Feedback Form:


Au Register Forms by Colorlib
localhost/final/baliraja_Part4/feedback.php
Incognito
Select Language
Home
Type here to search
ENG
00:32
25-07-2020

FEEDBACK FOR CROP

Crop: Choose completed crop

- Choose completed crop
- Wheat for 1.3 Hectares

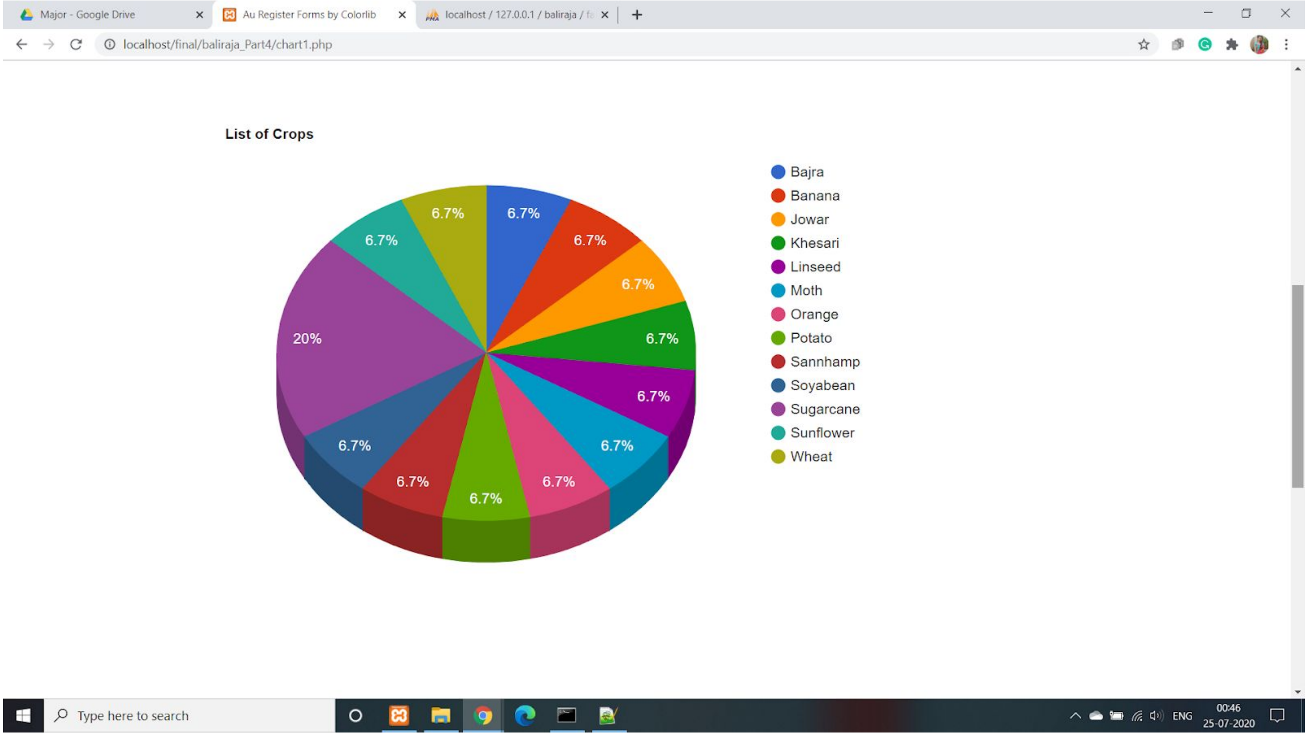
Additional Message

How does Recommended crop works?

○ Very Satisfied ○ Satisfied ○ Neutral ○ Unsatisfied ○ Very Unsatisfied

SUBMIT

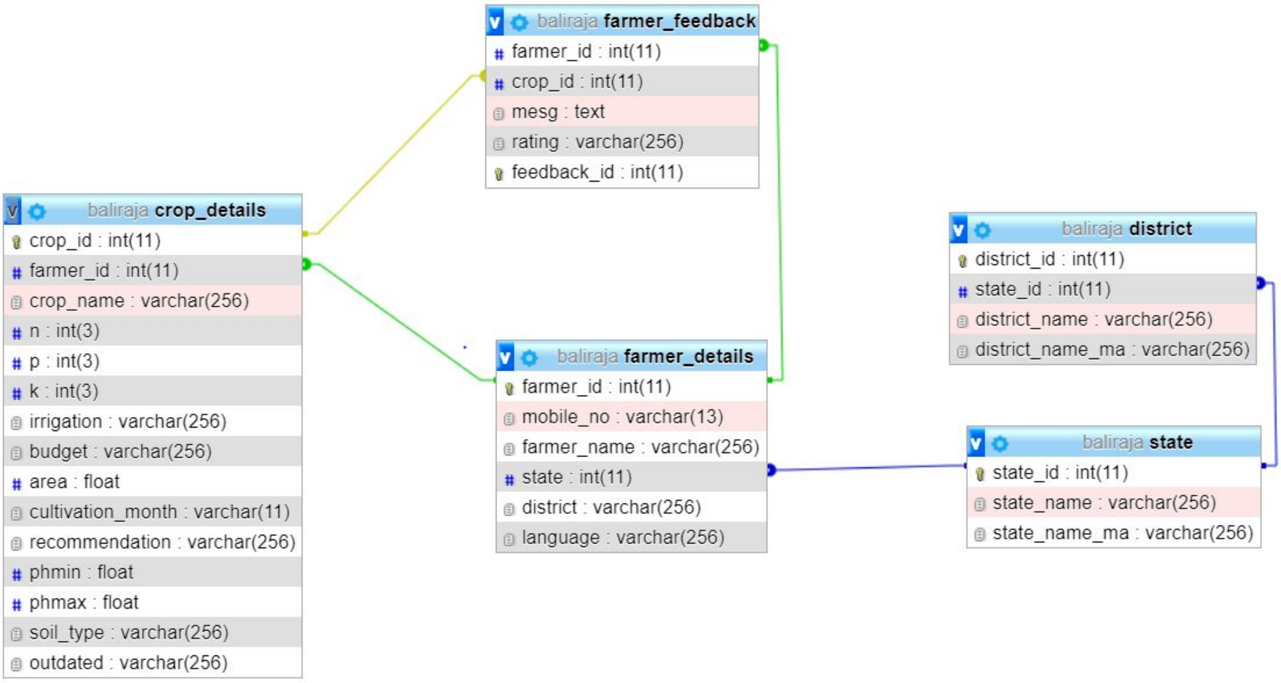
4.1.1.10. Location wise Crop Visualization:



4.1.2. Database:

The database contains 5 different tables which are farmer_details, crop_details, farmer_feedback, state, district. Farmer related details like a mobile number, farmer name, state, district, and language get stored into farmer_details. crop_details contain information related to crops like crop name, N, P, K, min-pH, max-pH, soil type, budget, land-area, Irrigation type, recommendation or alert and the crop is outdated or not.

Table farmer_details and crop_details has one to many relationships like one farmer can register for multiple crops. If a farmer wants to remove the crop from his dashboard the outdated column in the crop_details gets updated to 'Yes'. If users wish to fill feedback forms, the details of feedback forms like crop rating and the additional message get stored into feedback_details. farmer_details and crop_details have one to many relation to feedback details. state and district also have one to many relationship state tables that contain all state names in India and the district table contains all districts of the respective state.



baliraja farmer_feedback
farmer_id : int(11)
crop_id : int(11)
mesg : text
rating : varchar(256)
feedback_id : int(11)

baliraja crop_details
crop_id : int(11)
farmer_id : int(11)
crop_name : varchar(256)
n : int(3)
p : int(3)
k : int(3)
irrigation : varchar(256)
budget : varchar(256)
area : float
cultivation_month : varchar(11)
recommendation : varchar(256)
phmin : float
phmax : float
soil_type : varchar(256)
outdated : varchar(256)

baliraja farmer_details
farmer_id : int(11)
mobile_no : varchar(13)
farmer_name : varchar(256)
state : int(11)
district : varchar(256)
language : varchar(256)

baliraja district
district_id : int(11)
state_id : int(11)
district_name : varchar(256)
district_name_ma : varchar(256)

baliraja state
state_id : int(11)
state_name : varchar(256)
state_name_ma : varchar(256)

Fig 4.2. Database Schema

4.1.3. ML model:

Steps to build ML model[10]:

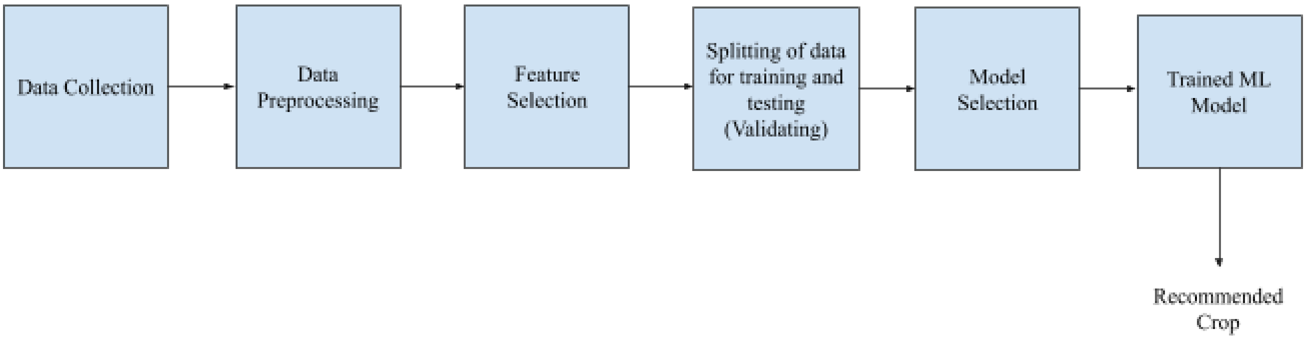


Fig 4.3. Steps in ML model Training

4.1.3.1. Data Collection and Preprocessing:

There are very few datasets available for agriculture. Because of this, the data has been collected from the agriculture department experts, Krishi-Darshani 2019 book, Kaggle and some other reliable books. Data is properly preprocessed using various methods like isna, fillna, dropna, etc and techniques to create a proper dataset[11], [12], [13].

Two different datasets are used for Irrigated and Non-Irrigated land ML models. Non-Irrigated land crops are dependent on rainfall. So, the district and month-wise rainfall data is also used which is generated by logistic regression on rainfall data from 1901 to 2015[13].

4.1.3.2. Feature selection:

The following features are selected in the Irrigated land dataset which majorly affects the prediction of labels:

- Soil: There are 6 types of soil in India. It indicates the type of soil required for a given crop.
- Month: It indicates in which month crop can be cultivated.
- State: It indicates in which state crops can be cultivated.
- N: It indicates the required Nitrogen value for a crop in the NPK ratio.
- P: It indicates the required Phosphorus value for a crop in the NPK ratio.
- K: It indicates the required Potassium value for a crop in the NPK ratio.
- Min-pH: It indicates the required minimum pH for a crop.
- Max-pH: It indicates the required maximum pH for a crop.

The following features are selected in the Non-Irrigated land dataset which majorly affects the prediction of labels:

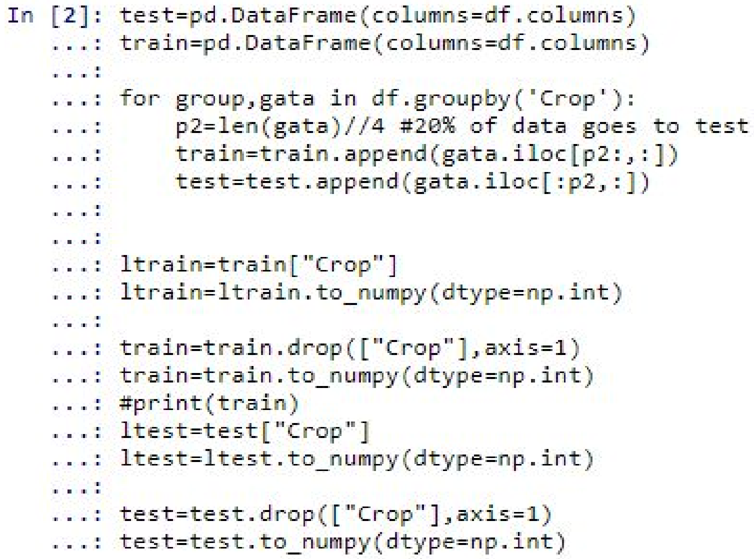
- Min-pH: It indicates the required minimum pH for a crop.
- Max-pH: It indicates the required maximum pH for a crop.
- Min-Rainfall: It indicates minimum rainfall required for a crop.
- Max-Rainfall: It indicates maximum rainfall required for a crop.
- N: It indicates the required Nitrogen value for a crop in the NPK ratio.
- P: It indicates the required Phosphorus value for a crop in the NPK ratio.
- K: It indicates the required Potassium value for a crop in the NPK ratio.

The following features are considered in the creation of month and district wise Rainfall dataset using Logistic regression for Non-Irrigated land dataset(Min-Rainfall, Max-Rainfall):

- State: It indicates the names of Indian states which are considered in the rainfall dataset.
- District: It indicates the names of state-wise districts that are considered in the rainfall dataset.
- Months: It indicates a total of 12 columns for individual monthly rainfall of a specific region. eg. January, February, etc.
- Season: It indicates season-wise rainfall in Jan-Feb, Mar-May, Jun-Sep, Oct-Dec in these 4 columns of a specific region.
- Annual Rainfall: It indicates Annual rainfall for that region.

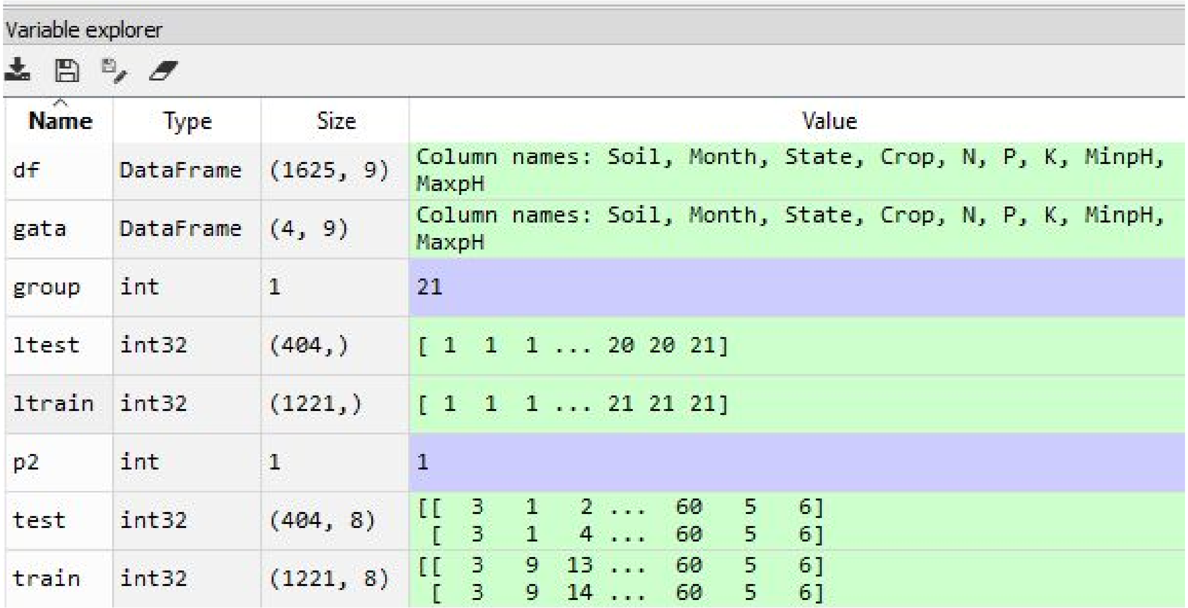
4.1.3.3. Training and Testing Dataset:

One can split data into training and testing data for models. Both Irrigated and Non-Irrigated land ML models trained on 80% dataset and Validated on the remaining 20% dataset. As the Irrigated land dataset is highly unbalanced, but the Python code of splitting the dataset takes care that all types of labels come under testing and training data.



```
In [2]: test=pd.DataFrame(columns=df.columns)
   ...: train=pd.DataFrame(columns=df.columns)
   ...:
   ...: for group,gata in df.groupby('Crop'):
   ...:     p2=len(gata)//4 #20% of data goes to test
   ...:     train=train.append(gata.iloc[p2:,:])
   ...:     test=test.append(gata.iloc[:p2,:])
   ...:
   ...:
   ...: ltrain=train["Crop"]
   ...: ltrain=ltrain.to_numpy(dtype=np.int)
   ...:
   ...: train=train.drop(["Crop"],axis=1)
   ...: train=train.to_numpy(dtype=np.int)
   ...: #print(train)
   ...: ltest=test["Crop"]
   ...: ltest=ltest.to_numpy(dtype=np.int)
   ...:
   ...: test=test.drop(["Crop"],axis=1)
   ...: test=test.to_numpy(dtype=np.int)
```

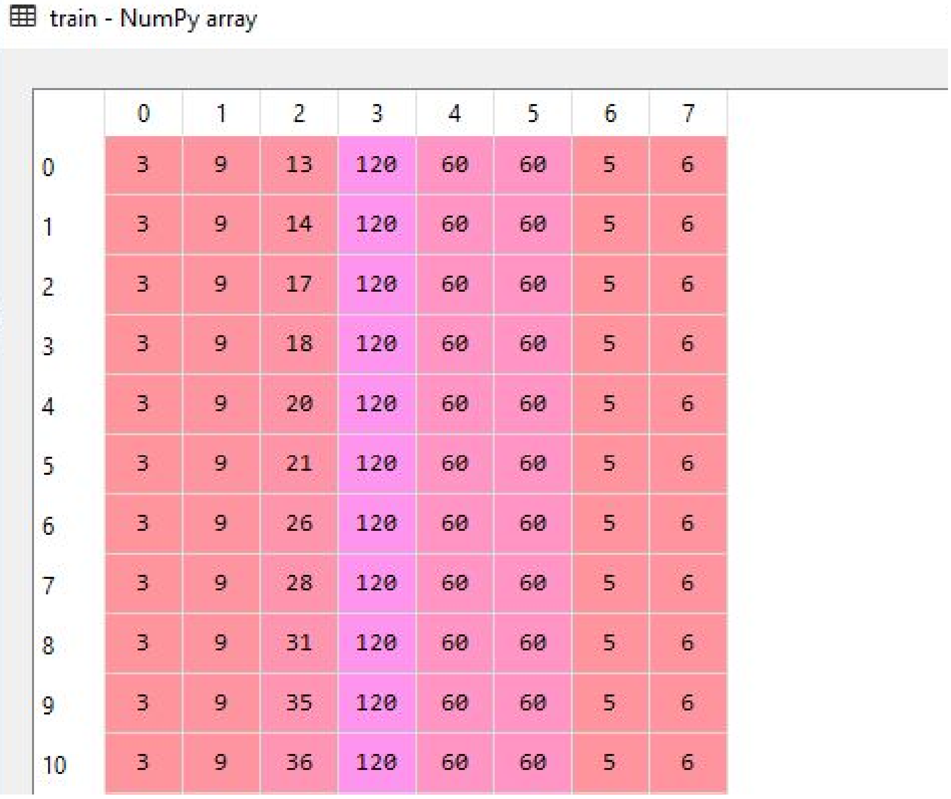
Fig 4.4. Python Code Snippet for Splitting Unbalanced Irrigated Land Dataset



Variable explorer

Name	Type	Size	Value
df	DataFrame	(1625, 9)	Column names: Soil, Month, State, Crop, N, P, K, MinpH, MaxpH
gata	DataFrame	(4, 9)	Column names: Soil, Month, State, Crop, N, P, K, MinpH, MaxpH
group	int	1	21
ltest	int32	(404,)	[1 1 1 ... 20 20 21]
ltrain	int32	(1221,)	[1 1 1 ... 21 21 21]
p2	int	1	1
test	int32	(404, 8)	[[3 1 2 ... 60 5 6] [3 1 4 ... 60 5 6]
train	int32	(1221, 8)	[[3 9 13 ... 60 5 6] [3 9 14 ... 60 5 6]

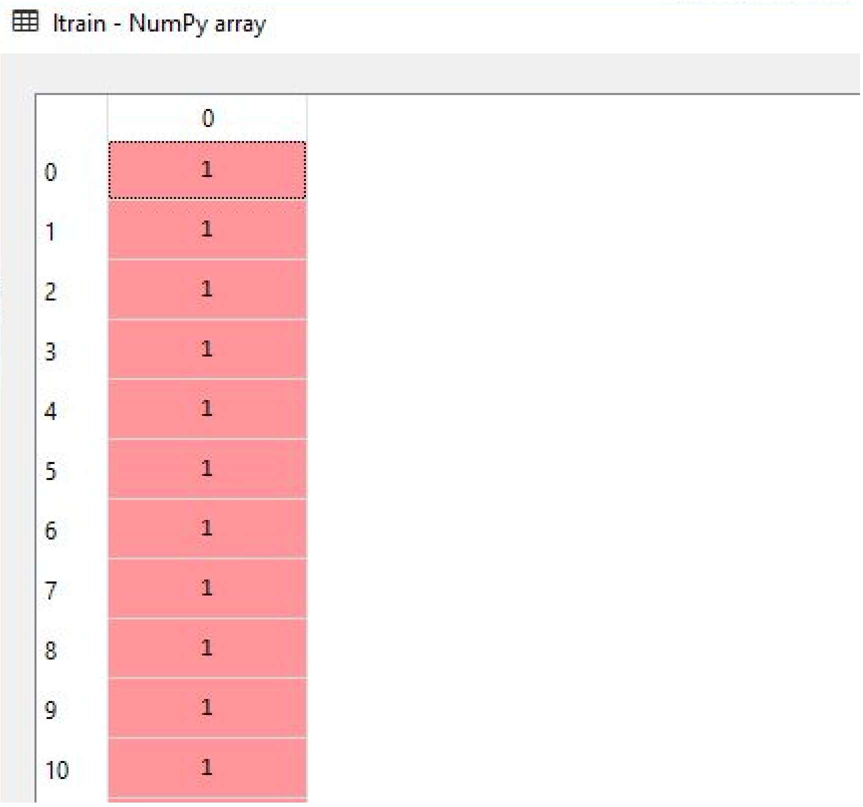
Fig 4.5. Variable Explorer



train - NumPy array

	0	1	2	3	4	5	6	7
0	3	9	13	120	60	60	5	6
1	3	9	14	120	60	60	5	6
2	3	9	17	120	60	60	5	6
3	3	9	18	120	60	60	5	6
4	3	9	20	120	60	60	5	6
5	3	9	21	120	60	60	5	6
6	3	9	26	120	60	60	5	6
7	3	9	28	120	60	60	5	6
8	3	9	31	120	60	60	5	6
9	3	9	35	120	60	60	5	6
10	3	9	36	120	60	60	5	6

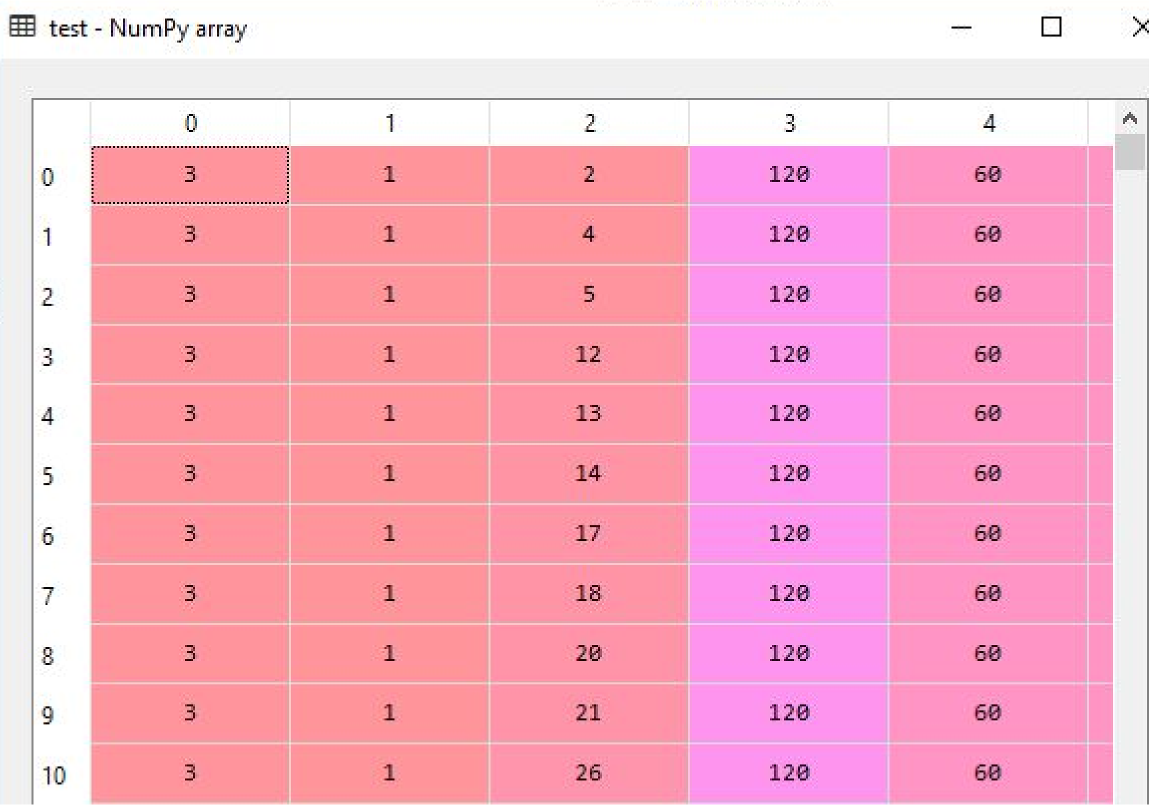
Fig 4.6. Training Data



ltrain - NumPy array

	0
0	1
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1

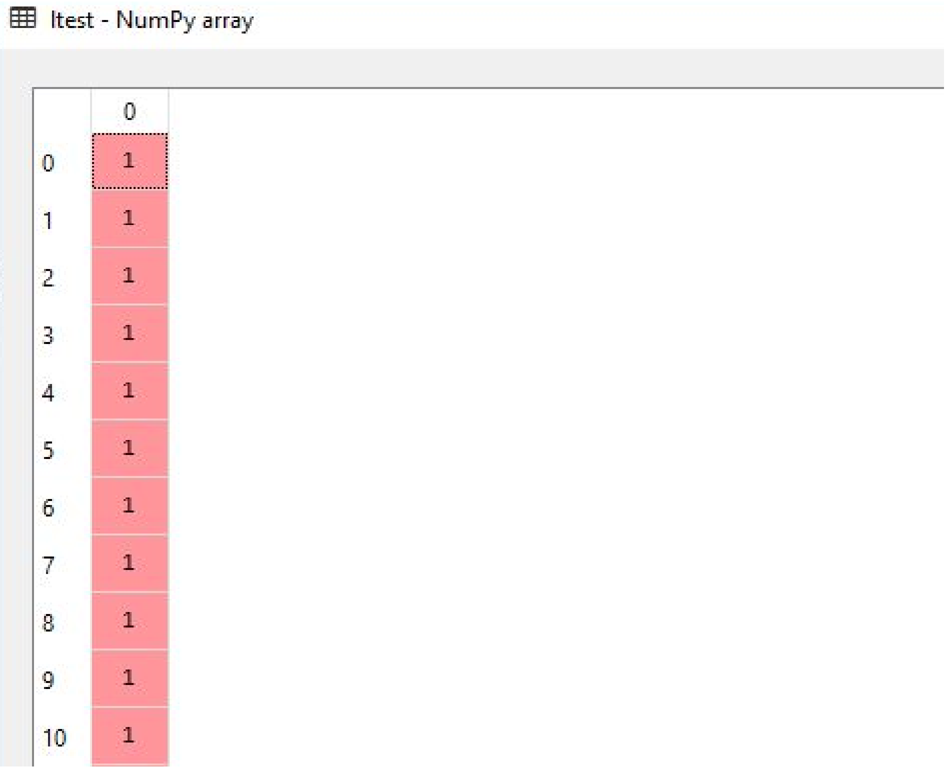
Fig 4.7. Training Label Data



test - NumPy array

	0	1	2	3	4
0	3	1	2	120	60
1	3	1	4	120	60
2	3	1	5	120	60
3	3	1	12	120	60
4	3	1	13	120	60
5	3	1	14	120	60
6	3	1	17	120	60
7	3	1	18	120	60
8	3	1	20	120	60
9	3	1	21	120	60
10	3	1	26	120	60

Fig 4.8. Testing Data



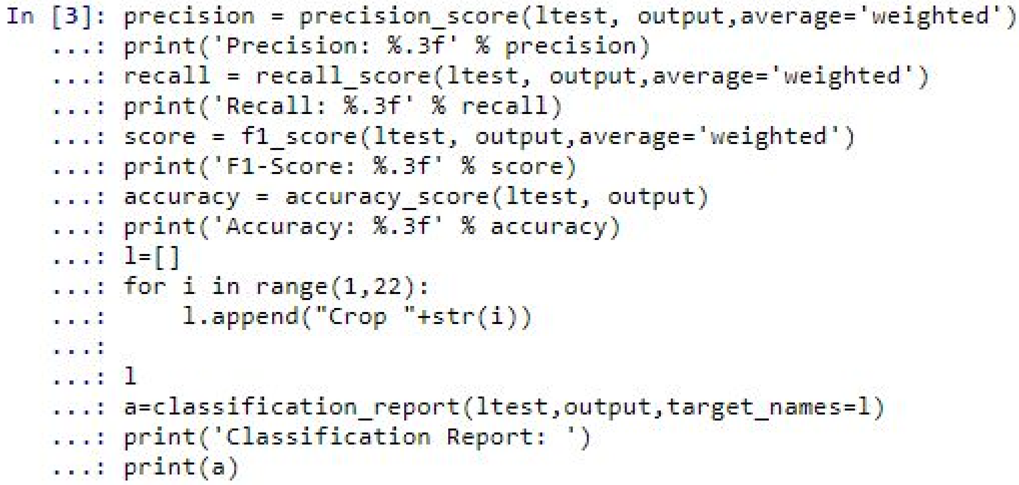
ltest - NumPy array

	0
0	1
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1

Fig 4.9. Testing Label

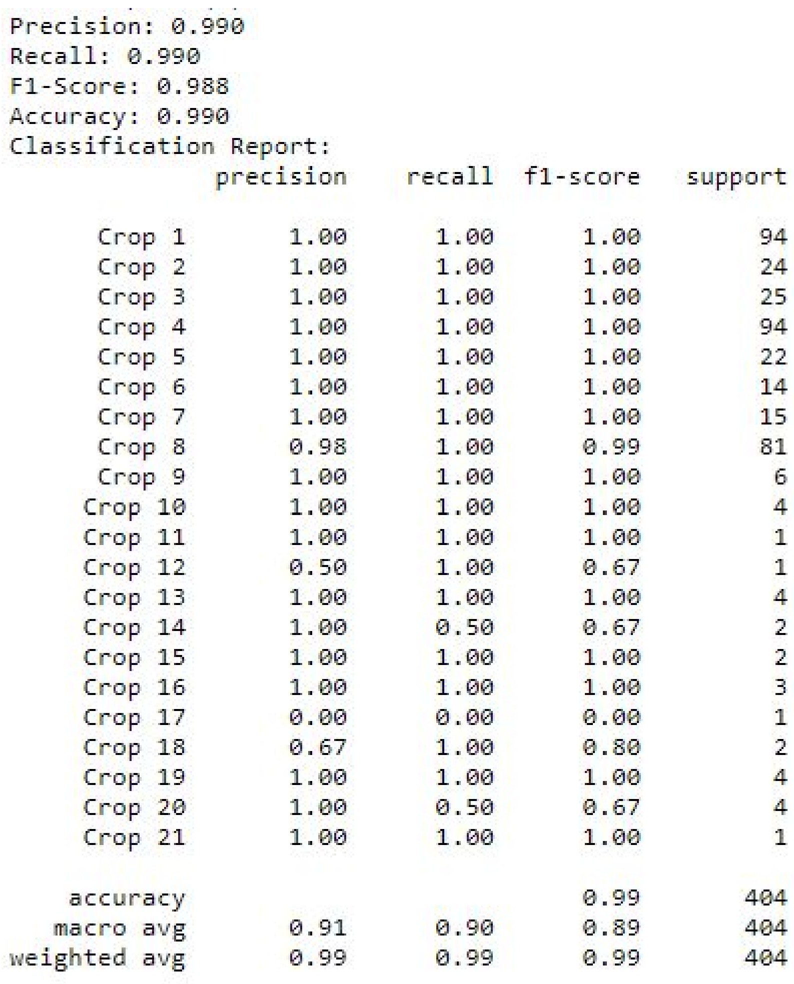
4.1.3.4. Model Selection:

Various algorithms and techniques can be used for training ML models. But one can distinguish them based on various testing metrics[16]. You can easily see which one performed the best for your testing data after its training. The algorithms giving consistently high scores is the target. You can then take the top ones and tune them further to improve their performance. Performance metrics used here are Accuracy, Precision, Recall, F1-Score and AUC Score(Area Under Curve) to decide well-suited algorithm(s).



```
In [3]: precision = precision_score(ltest, output,average='weighted')
   ...: print('Precision: %.3f' % precision)
   ...: recall = recall_score(ltest, output,average='weighted')
   ...: print('Recall: %.3f' % recall)
   ...: score = f1_score(ltest, output,average='weighted')
   ...: print('F1-Score: %.3f' % score)
   ...: accuracy = accuracy_score(ltest, output)
   ...: print('Accuracy: %.3f' % accuracy)
   ...: l=[]
   ...: for i in range(1,22):
   ...:     l.append("Crop "+str(i))
   ...:
   ...: l
   ...: a=classification_report(ltest,output,target_names=l)
   ...: print('Classification Report: ')
   ...: print(a)
```

Fig 4.10. Python Code Snippet for Testing ML Models on Various Metrics



```
Precision: 0.990
Recall: 0.990
F1-Score: 0.988
Accuracy: 0.990
Classification Report:
              precision    recall  f1-score   support

      Crop 1       1.00      1.00      1.00        94
      Crop 2       1.00      1.00      1.00        24
      Crop 3       1.00      1.00      1.00        25
      Crop 4       1.00      1.00      1.00        94
      Crop 5       1.00      1.00      1.00        22
      Crop 6       1.00      1.00      1.00        14
      Crop 7       1.00      1.00      1.00        15
      Crop 8       0.98      1.00      0.99        81
      Crop 9       1.00      1.00      1.00         6
     Crop 10       1.00      1.00      1.00         4
     Crop 11       1.00      1.00      1.00         1
     Crop 12       0.50      1.00      0.67         1
     Crop 13       1.00      1.00      1.00         4
     Crop 14       1.00      0.50      0.67         2
     Crop 15       1.00      1.00      1.00         2
     Crop 16       1.00      1.00      1.00         3
     Crop 17       0.00      0.00      0.00         1
     Crop 18       0.67      1.00      0.80         2
     Crop 19       1.00      1.00      1.00         4
     Crop 20       1.00      0.50      0.67         4
     Crop 21       1.00      1.00      1.00         1

    accuracy                           0.99       404
   macro avg       0.91      0.90      0.89       404
weighted avg       0.99      0.99      0.99       404
```

Fig 4.11. Results of Ensemble Model on various Metrics

After comparing all the algorithms, we encountered that the Ensembles technique is the most suitable for the Irrigated land ML model and combination of both the Rule-based and the Decision tree classifier suited for the Non-Irrigated land ML model.

In the Irrigated land ML model, the Ensemble technique[15] is used for training. The ensemble is a data mining model also known as the Committee Methods or Model Combiners, that combine the power of multiple models to acquire greater prediction and efficiency than any of its models could achieve alone. In this system, the most familiar ensemble technique Majority Voting technique has been used. In the voting technique, three base learners are used. The learners are chosen in a way that they are competent to each other and complementary also. Higher the competition, the higher is the chance of better prediction. It is necessary for the learners to be complementary because when one or a few members make an error, the probability of the remaining members correcting this error would be high. Each learner builds itself into a model. The model gets trained using the training data set provided. When a new sample has to be classified, each model predicts the class on its own. Finally, the class which is predicted by the majority of the learners is voted to be the class label of the new sample[4].

Base learners for the Ensemble Model are as below:

- Random Forest[17]: It is an ensemble tree-based learning algorithm. The Random Forest Classifier is a set of decision trees from a randomly selected subset of the training set. It aggregates the votes from different decision trees to decide the final class of the test object.
- Logistic Regression[17]: Logistic regression is a statistical model that in its basic form uses a logistic function, although many more complex extensions exist. Multinomial logistic regression (often just called 'multinomial regression') is used to predict a nominal dependent variable given one or more independent variables.
- Naive Bayes(Gaussian NB)[17]: Naive Bayes classifier is a simple probabilistic classifier that works based on applying Bayes' theorem with strong naive independence assumptions. Naive Bayes is a technique for constructing classifier models that assign class labels to problem instances which are represented as vectors of feature values, where the class labels are drawn from some finite set. It is not just a single algorithm for training such classifiers, but a family of algorithms based on a common principle. All naive Bayes classifiers assume that the value of a particular feature is independent of the value of any other feature, given the class variable.

Decision tree[17] is used as a meta learner. Decision trees are constructed via an algorithmic approach that identifies ways to split a data set based on different conditions. It is one of the most widely used and practical methods for supervised learning. Decision Trees are a non-parametric supervised learning method used for both classification and regression tasks. The goal is to create a model that predicts the value of a target variable by learning simple decision rules inferred from the data features.

In Non-Irrigated Land Model Rule-based machine learning (RBML) is used. It is to encompass any machine learning method that identifies, learns, or evolves 'rules' to apply. A rule-based approach to regulation prescribes in detail or gives a set of rules. A rules-based system could be considered as having “fixed” intelligence. The decision tree classifier works as a backup algorithm for RBML.

4.1.4. Model Serialization:

Once the irrigated and Non-Irrigated ML model is finalized with good accuracy results, then a pickle file with .pkl extension is generated. Pickle is the standard way of serializing and deserializing objects in python. The object is converted into the byte stream where dump() method to serialize ML model and save the serialized format to file and load() method load this file to deserialize ML model and use it for new predictions. This is the process of how the pickle file is used as an ML model.

4.1.5. Crop Recommendation Flask Server:

The next part is to make an API that receives input crop details from the front end and passes that data to the ML model that gives the crop recommendation. Flask is a light web framework and it is used to create API. This acts as an API interface to connect it with the frontend. The main objective of the API is to pass the output generated from the ML model to the frontend.

On submitting form values using POST requests based on farmer selected options(Irrigated or Non-Irrigated) are converted to JSON format. Data is passed from the front end to the Flask server and this is done by the cURL library of PHP. cURL is a client URL. It allows you to connect with other URLs and get the response. The curl library calls Flask API[18] with jsonified input data. Then Flask API decodes that data and passes it to the trained ML model and the ML model will recommend the crop. API will return the prediction after converting it into the JSON format. The predicted result will go to the cURL library as a response. Lastly, the response is decoded and displayed on the frontend.

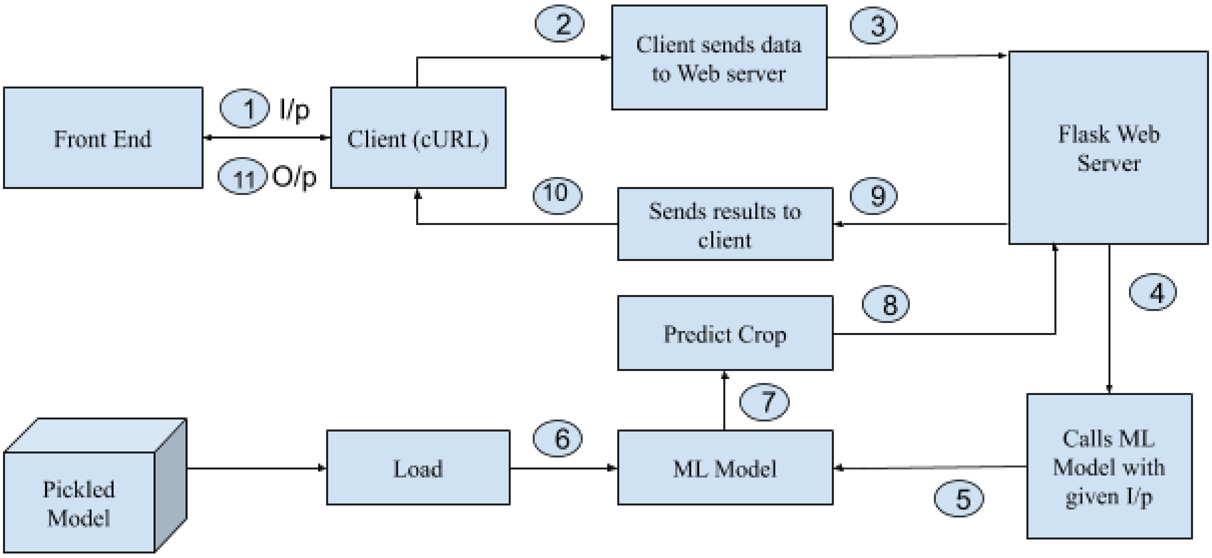


Fig 4.12. Crop Recommendation Flask Server

4.1.6. 'Naradwani' Alert Model:

It sends SMS alerts to the farmer's mobile numbers for recommended/registered crops. So, they can apply an appropriate treatment on time, when favorable conditions occur for a pest/insect/disease outbreak. The risk alerting system checks the database and fetches all distinct location wise weather forecasts for the future 5 days from OpenWeather API[7]. For this purpose, it uses the district name as an input. Forecast data includes temperature, humidity and weather description. The CSV file contains all pest/insect/disease names which affect crops with their temperature and humidity range. Now, if the temperature and humidity are favorable for the pest outbreak, the alert model will fetch all the farmers that are registered for that crop and are alerted for the potential pest/insect/disease outbreak. The SMS alert also contains the treatment information for the outbreak.

The SMS alerts are sent to the farmers in their selected local languages. The googletrans library is used for translating the SMS into different languages. FAST2SMS is an SMS gateway[8] used for sending SMS in bulk to farmers' registered mobile numbers. As a result, farmers will have higher knowledge and more consistent yield.

Cron is a Linux command which is a time-based job scheduler and jobs assigned to Cron are known as Cron jobs[9]. Users use cron to schedule jobs and to run them periodically at fixed times, dates or intervals. So, the Naradwani system is assigned to the cron environment in Baliraja's backend to run every Monday to fetch the next 5 days weather forecast. Proper integration with the database of the system is done to access it securely and consistently. But it is hard to implement Cron on other OS than Linux. So Cron job-like environments are provided using Python libraries like DateTime, _datetime, schedule, etc to avoid problems while deploying.

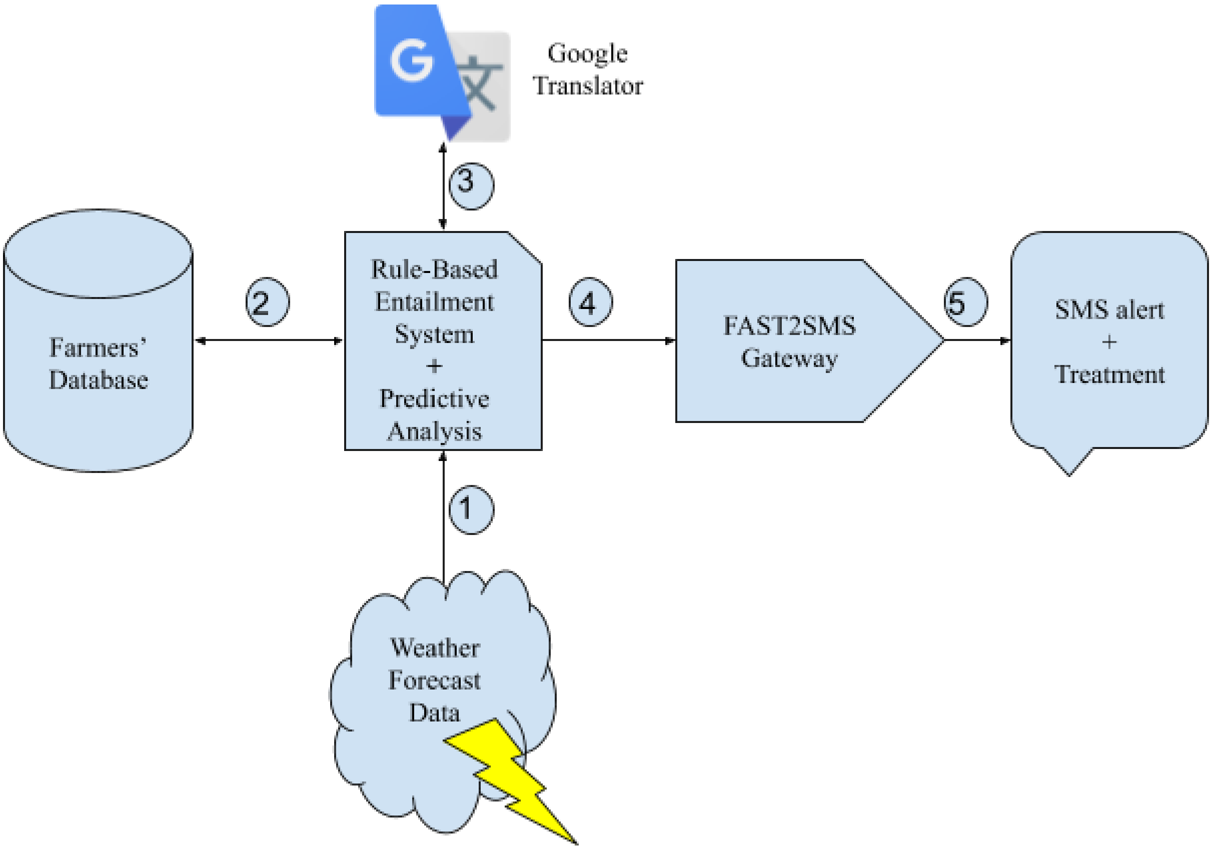


Fig 4.13. Working of Naradwani System

4.2. UML Diagrams:

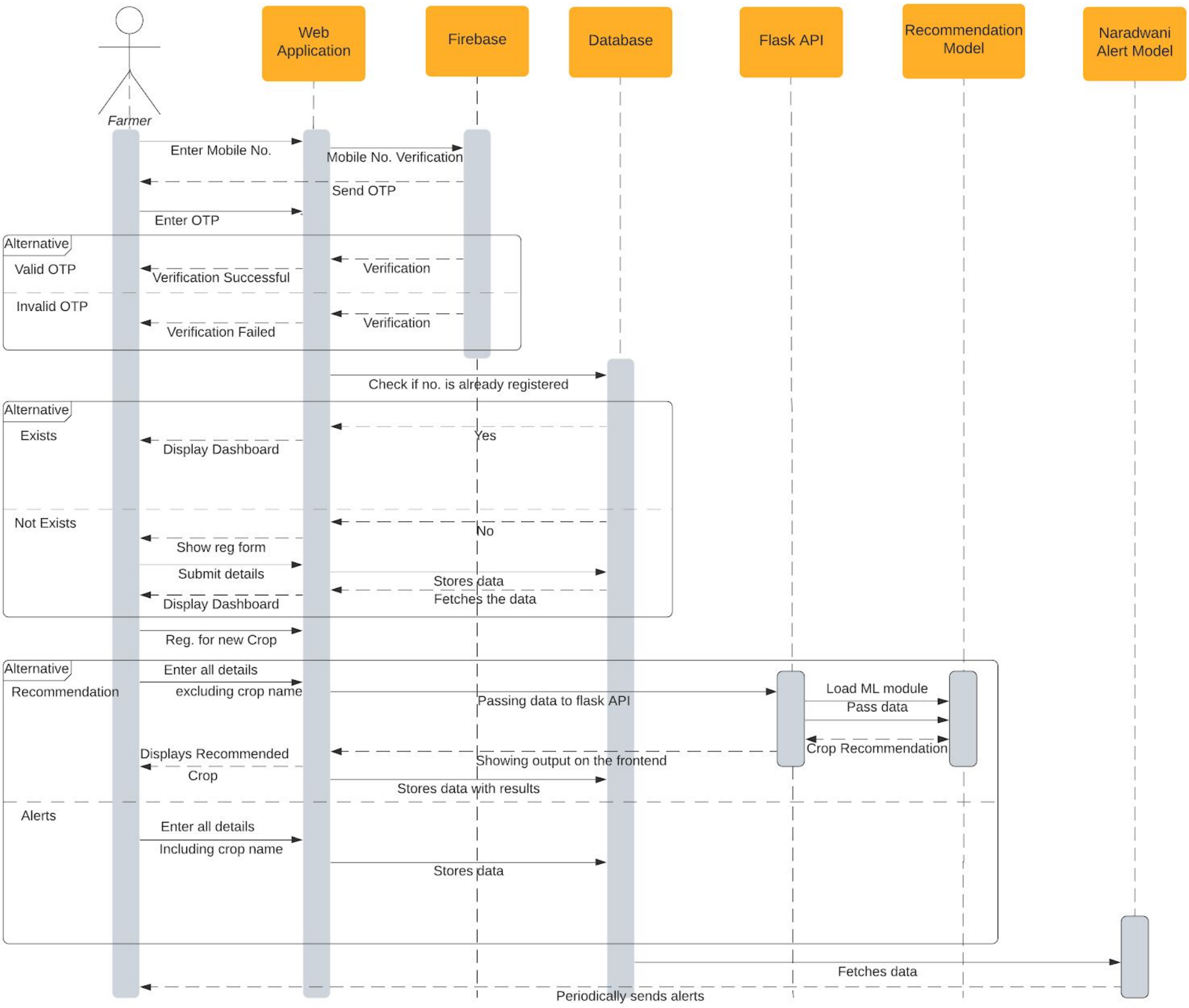


Fig 4.14. Sequence Diagram

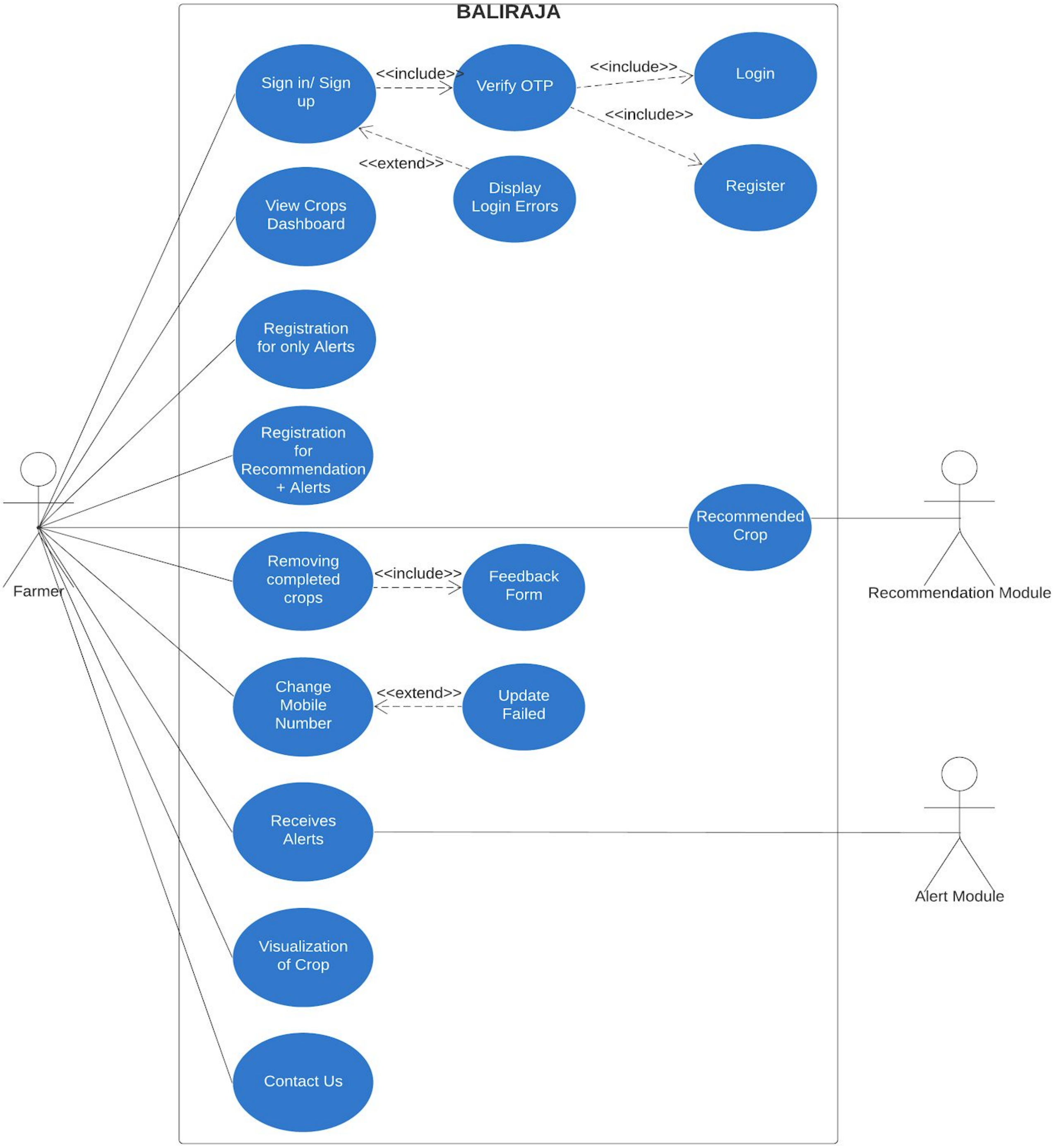


Fig 4.15. Use Case Diagram

4.3. Improvements Over Existing Systems and Additional Features:

4.3.1. High Accuracy Prediction:

Ensemble-based Machine Learning which is trained on a huge dataset consisting of various features, which helps to recommend Crop more accurately rather than existing systems. The ML model is divided into irrigated and Non-Irrigated models by dividing the data for irrigated land and Non-Irrigated land. As Non-Irrigated land is dependent on rain for crop production hence rainfall of the region is considered while prediction. So, this increases the accuracy of the ML model.

4.3.2. Crop Alerts and Weather Forecast:

If conditions are favorable for Pest/Diseases/Insect outbreak then alerts with the name of most probable Pest/Diseases/Insects are sent through SMS along with the Treatment/Precautions in their local language. Also, forecasts about Rainfall as well as mean temperature and humidity are sent through SMS to all users so that even non-smartphones can get the weather updates.

4.3.3. Variety of Crops for Irrigated and Non-Irrigated System:

There are more than 20 crops for irrigated and more than 60 crops for Non-Irrigated land. So, there are a large number of crops for both Irrigated and Non-Irrigated land crops which cover almost all major crops of India.

4.3.4. Responsive and Multilingual Web Application:

The proposed system is a responsive one which means this web application can be accessed through any machine/device having internet. Also, this is available in more than 100 global languages so that all farmers can easily understand and use the system.

4.3.5. Consistent and Faster Prediction:

As the ML model is converted to Flask API so it will give a consistent and faster prediction.

5. DEPENDENCIES AND REQUIREMENTS

5.1. Hardware Requirements:

5.1.1. Windows: An Intel Pentium 4 processor or later that's SSE2 capable

5.1.2. Mac: An Intel Pentium 4 processor or later

5.1.3. Linux: An Intel Pentium 4 processor or later that's SSE2 capable

5.1.4. Android: A dual-core processor with at least 512mb of ram.

5.2. Software Requirements:

5.2.1. Operating systems:

5.2.1.1. Windows: Windows XP, Windows Vista, Windows 7, Windows 8, Windows 8.1, Windows 10 or later.

5.2.1.2. Mac: Mavericks, Yosemite, El Capitan, Sierra, and High Sierra (or OSX/macOS 10.9+).

5.2.1.3. Linux: 64-bit Ubuntu 14.04+.

5.2.1.4. Android: Android 4 and newer.

5.2.1.5. iOS: iOS 10 and newer.

5.2.2. Browsers:

5.2.2.1. MAC OS: Firefox, Chrome, Opera, Safari.

5.2.2.2. Windows OS: Firefox, Chrome, Opera, Edge, and Microsoft Edge.

5.2.2.3. Linux: Firefox, Chrome, Opera, Chromium, Vivaldi.

5.2.2.4. iOS: Safari, Chrome, Edge, Opera Touch.

5.2.2.5. Android: Safari, Chrome, Edge, Opera, Brave, Dolphin Browser.

5.2.3. Software:

Python 3.5 or higher

Anaconda 3 or higher

Xampp 3.2.4

Google Chrome 84.0.4147.125

5.2.4. IDE's Used:

PyCharm Community Edition for Flask API

Spyder for the ML model

Brackets 1.14.1.

Note:

- A good internet connection is recommended.
- JavaScript and Cookies should be enabled in any browser, which the user chooses to use.
- The project adopted a responsive web design that can be displayed with each user's resolution. That's why it is recommended to use the browser that is suitable for CSS3 Media Queries in the case of iOS/Android.

5.3. FAST2SMS:

The Developer Account(The account that is created on FAST2SMS and used to send SMS) should have enough credits to send SMS in bulk[8].

5.4. Open Weather:

The Developer Account(The account through which the API key is generated and is used to fetch weather forecasts) should have enough credits to fetch weather forecasts of the given location[7].

6. INSTRUCTIONS FOR DEPLOYMENT

Follow the given steps to deploy and run this project:

Step 1: Download and install Python 3.5 or higher version and XAMPP server.

Step 2: Download the project repository.

Step 3: Create a virtual environment and activate virtualenv.

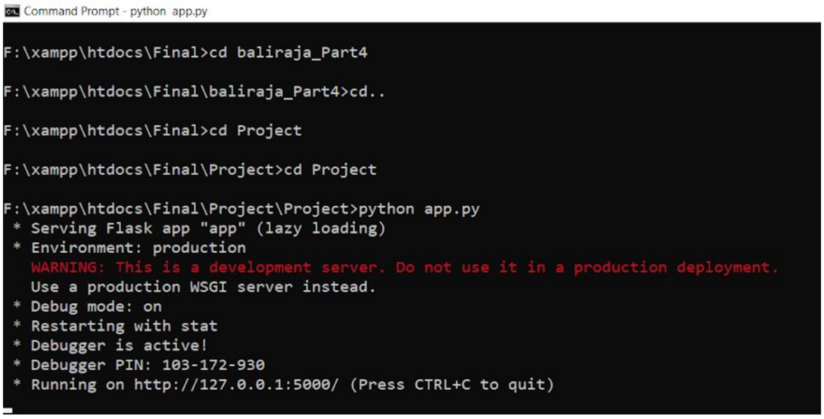
Step 4: Open directory where requirement.txt file is located and run “pip install -r requirements.txt”. It will install all the required packages for the project.

Step 5: Enable the curl library if it is not enabled by using the following steps:

1. Open php.ini file, it is usually located in the server’s root folder
2. Search the ;extension=php_curl.dll and remove the semicolon ‘;’ before it to enable.
3. Save and close the file. Restart server.

Step 6: Copy Baliraja folder to xampp/htdocs folder and import baliraja.sql file to the MySQL database.

Step 7: Run app.py to start flask server.



```
Command Prompt - python  app.py

F:\xampp\htdocs\Final>cd baliraja_Part4

F:\xampp\htdocs\Final\baliraja_Part4>cd..

F:\xampp\htdocs\Final>cd Project

F:\xampp\htdocs\Final\Project>cd Project

F:\xampp\htdocs\Final\Project\Project>python app.py
 * Serving Flask app "app" (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production deployment.
   Use a production WSGI server instead.
 * Debug mode: on
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 103-172-930
 * Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
```

Fig 6.1. Demonstration to Run app.py

Step 8: Start XAMPP server and Go to the browser and type localhost://Baliraja

Note:

- Create a FAST2SMS account and get an API key[8]. Now change the same in the alert model(Alert.py).
- Create an OpenWeather account and get an API key[7]. Now change the same in the alert model(Alert.py).

7. SUMMARY

Each and every sector in this digital world is undergoing a drastic change due to the influence of Machine learning. But today, not much work has been done in the agricultural sector. **"BaliRaja": A Crop Recommendation And Risk Alerting System** is a responsive web application. It helps farmers in crop selection for cultivation with most minimum risks and also alerts farmers about possible pest/insect/disease outbreak on farmers' registered crops which in turn reduces crop losses. It is a multilingual web application. The crop recommendation system has an Ensemble-based ML model on the backend that is trained on a dataset collected through agricultural experts, Krishi-Darshani book and other well-known sources. The main objective of this system is to recommend crops. For this farmers are expected to input some required fields based on which the ML model recommends the crop. This project is an integration of both crop recommendation and crop risk alert system which is the biggest advantage over existing systems in the market. This web application is very easy to use and can be accessed through any device.

The Predictions can be improved if more attributes are considered but lack of data reduces the parameters of the ML model. This can be further improved by improving the data set with more number of attributes in the prediction model.

In conclusion, we can say that if proper and optimized recommendations are given to farmers it will definitely help in building the economical status of agricultural production dependent countries. As developers, we learned a lot of new technologies through tutorials, online articles and with the help of our guide. Apart from this, we have learned to work as a team. This project is also appreciated by the Zonal Agriculture Research Station, Solapur under Mahatma Phule Krishi Vidyapeeth Rahuri and Agricultural Produce Market Committee, Solapur with appreciation letters.

8. FUTURE WORK

The accuracy of crop recommendation can be further improved using reinforcement learning and feedback systems.

Adding fertilizer information for the recommended crop and sending risk alerts based on growth 3. stages of crops.

Considering crop rate fluctuations in the market and its effect on crops.

Our future work is aimed at an improved data set and adding more features to the system.

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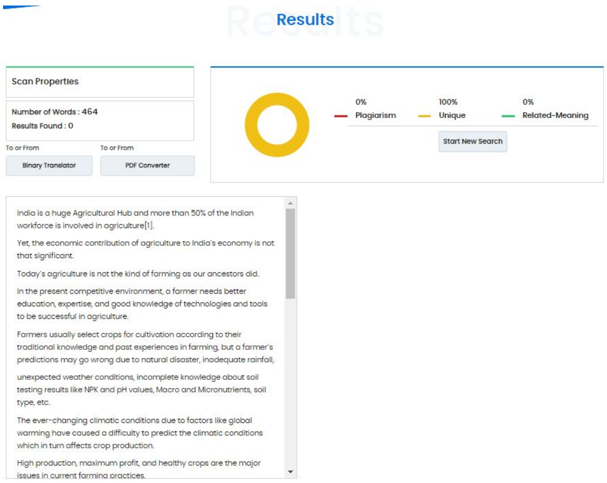
PLAGIARISM CHECK

Source: https://www.duplichecker.com/

Conclusion:

1. ABSTRACT:



Results

Scan Properties

Number of Words : 464

Results Found : 0

0% Plagiarism

100% Unique

0% Related-Meaning

India is a huge Agricultural Hub and more than 50% of the Indian workforce is involved in agriculture[1].

Yet, the economic contribution of agriculture to India's economy is not that significant.

Today's agriculture is not the kind of farming as our ancestors did.

In the present competitive environment, a farmer needs better education, expertise, and good knowledge of technologies and tools to be successful in agriculture.

Farmers usually select crops for cultivation according to their traditional knowledge and past experiences in farming, but a farmer's predictions may go wrong due to natural disaster, inadequate rainfall,

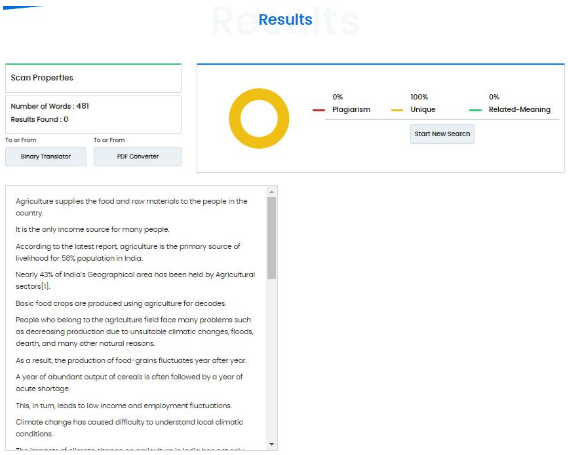
unexpected weather conditions, incomplete knowledge about soil testing results like NPK and pH values, Macro and Micronutrients, soil type, etc.

The ever-changing climatic conditions due to factors like global warming have caused a difficulty to predict the climatic conditions which in turn affects crop production.

High production, maximum profit, and healthy crops are the major issues in current farming practices.

2. INTRODUCTION:

a.



Results

Scan Properties

Number of Words : 481

Results Found : 0

0% Plagiarism

100% Unique

0% Related-Meaning

Agriculture supplies the food and raw materials to the people in the country.

It is the only income source for many people.

According to the latest report, agriculture is the primary source of livelihood for 58% population in India.

Nearly 43% of India's Geographical area has been held by Agricultural sectors[1].

Basic food crops are produced using agriculture for decades.

People who belong to the agriculture field face many problems such as decreasing production due to unsuitable climatic changes, floods, dearth, and many other natural reasons.

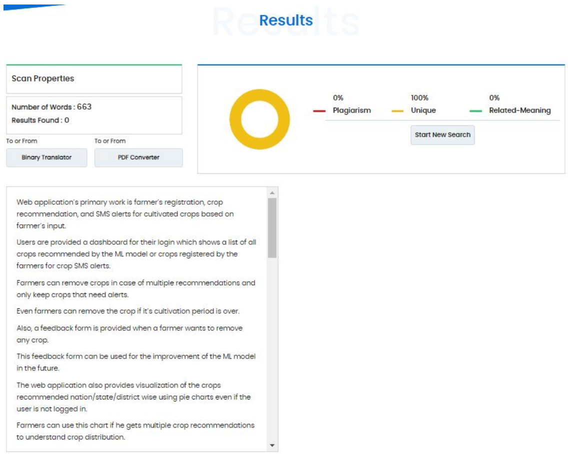
As a result, the production of food-grains fluctuates year after year.

A year of abundant output of cereals is often followed by a year of acute shortage.

This, in turn, leads to low income and employment fluctuations.

Climate change has caused difficulty to understand local climatic conditions.

b.



Results

Scan Properties

Number of Words : 663

Results Found : 0

0% Plagiarism

100% Unique

0% Related-Meaning

Web application's primary work is farmer's registration, crop recommendation, and SMS alerts for cultivated crops based on farmer's input.

Users are provided a dashboard for their login which shows a list of all crops recommended by the ML model or crops registered by the farmers for crop SMS alerts.

Farmers can remove crops in case of multiple recommendations and only keep crops that need alerts.

Even farmers can remove the crop if it's cultivation period is over.

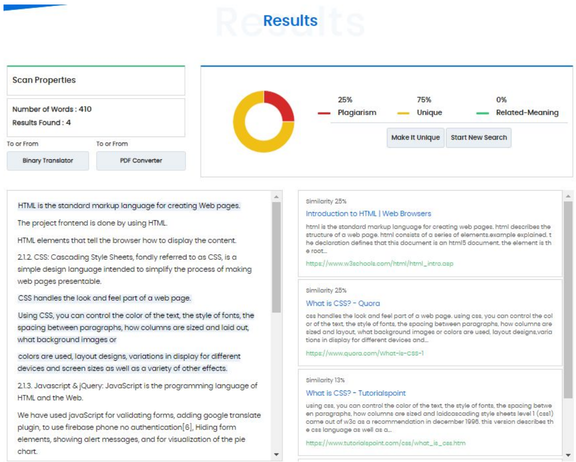
Also, a feedback form is provided when a farmer wants to remove any crop.

This feedback form can be used for the improvement of the ML model in the future.

The web application also provides visualization of the crops recommended nation/state/district wise using pie charts even if the user is not logged in.

Farmers can use this chart if he gets multiple crop recommendations to understand crop distribution.

c.



Results

Scan Properties

Number of Words : 410

Results Found : 4

25% Plagiarism

75% Unique

0% Related-Meaning

HTML is the standard markup language for creating Web pages.

The project frontend is done by using HTML.

HTML elements that tell the browser how to display the content.

2.1.2. CSS: Cascading Style Sheets, fondly referred to as CSS, is a simple design language intended to simplify the process of making web pages presentable.

CSS handles the look and feel part of a web page.

Using CSS, you can control the color of the text, the style of fonts, the spacing between paragraphs, how columns are sized and laid out, what background images or

colors are used, layout designs, variations in display for different devices and screen sizes as well as a variety of other effects.

2.1.3. Javascript & jQuery: JavaScript is the programming language of HTML and the Web.

We have used javaScript for validating forms, adding google translate plugin, to use firebase phone no authentication[6], Hiding form elements, showing alert messages, and for visualization of the pie chart.

Similarity 25%

Introduction to HTML | Web Browsers

html is the standard markup language for creating web pages. html describes the structure of a web page. html consists of a series of elements.example explained. t he declaration defines that this document is an html5 document. the element is th e root...

https://www.w3schools.com/html/html_intro.asp

Similarity 25%

What is CSS? - Quora

css handles the look and feel part of a web page. using css, you can control the col or of the text, the style of fonts, the spacing between paragraphs, how columns are sized and layout, what background images or colors are used, layout designs,varia tions in display for different devices and...

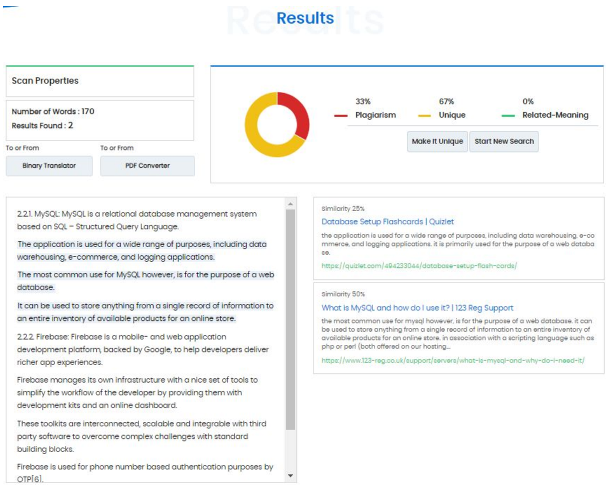
https://www.quora.com/What-is-CSS-1

Similarity 13%

What is CSS? - Tutorialspoint

using css, you can control the color of the text, the style of fonts, the spacing betwe en paragraphs, how columns are sized and laidcascading style sheets level 1 (css1) came out of w3c as a recommendation in december 1996. this version describes th e css language as well as a...

https://www.tutorialspoint.com/css/what_is_css.htm d.



Number of Words : 170

Results Found : 2

33% Plagiarism

67% Unique

0% Related-Meaning

2.2.1. MySQL: MySQL is a relational database management system based on SQL – Structured Query Language.

The application is used for a wide range of purposes, including data warehousing, e-commerce, and logging applications.

The most common use for MySQL however, is for the purpose of a web database.

It can be used to store anything from a single record of information to an entire inventory of available products for an online store.

2.2.2. Firebase: Firebase is a mobile- and web application development platform, backed by Google, to help developers deliver richer app experiences.

Firebase manages its own infrastructure with a nice set of tools to simplify the workflow of the developer by providing them with development kits and an online dashboard.

These toolkits are interconnected, scalable and integrable with third party software to overcome complex challenges with standard building blocks.

Firebase is used for phone number based authentication purposes by OTP[6].

Similarity 25%

Database Setup Flashcards | Quizlet

the application is used for a wide range of purposes, including data warehousing, e-commerce, and logging applications. it is primarily used for the purpose of a web database.

https://quizlet.com/494233044/database-setup-flash-cards/

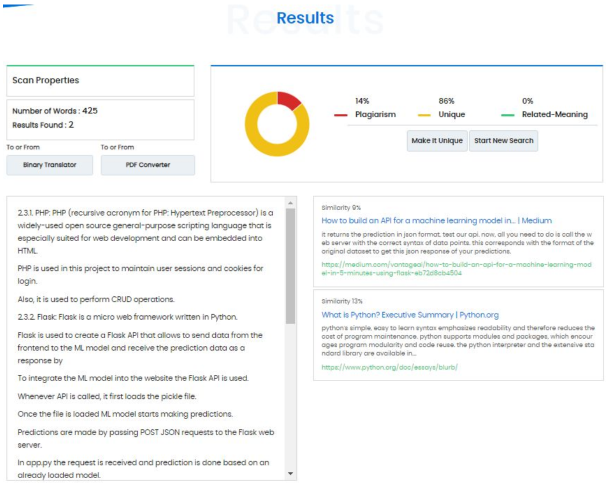
Similarity 50%

What is MySQL and how do I use it? | 123 Reg Support

the most common use for mysql however, is for the purpose of a web database. it can be used to store anything from a single record of information to an entire inventory of available products for an online store. in association with a scripting language such as php or perl (both offered on our hosting...

https://www.123-reg.co.uk/support/servers/what-is-mysql-and-why-do-i-need-it/

e.



Number of Words : 425

Results Found : 2

14% Plagiarism

86% Unique

0% Related-Meaning

2.3.1. PHP: PHP (recursive acronym for PHP: Hypertext Preprocessor) is a widely-used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML.

PHP is used in this project to maintain user sessions and cookies for login.

Also, it is used to perform CRUD operations.

2.3.2. Flask: Flask is a micro web framework written in Python.

Flask is used to create a Flask API that allows to send data from the frontend to the ML model and receive the prediction data as a response by

To integrate the ML model into the website the Flask API is used.

Whenever API is called, it first loads the pickle file.

Once the file is loaded ML model starts making predictions.

Predictions are made by passing POST JSON requests to the Flask web server.

In app.py the request is received and prediction is done based on an already loaded model.

Similarity 9%

How to build an API for a machine learning model in... | Medium

it returns the prediction in json format. test our api. now, all you need to do is call the web server with the correct syntax of data points. this corresponds with the format of the original dataset to get this json response of your predictions.

https://medium.com/vantageai/how-to-build-an-api-for-a-machine-learning-model-in-5-minutes-using-flask-eb72d8cb4504

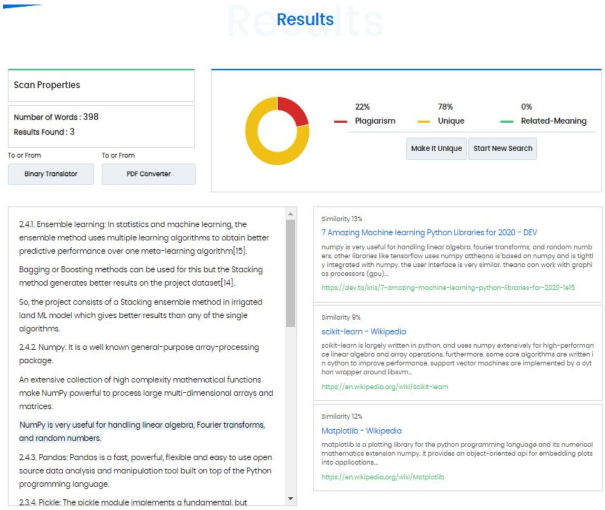
Similarity 13%

What is Python? Executive Summary | Python.org

python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. python supports modules and packages, which encourages program modularity and code reuse. the python interpreter and the extensive standard library are available in...

https://www.python.org/doc/essays/blurb/

f.



Number of Words : 398

Results Found : 3

22% Plagiarism

78% Unique

0% Related-Meaning

2.4.1. Ensemble learning: In statistics and machine learning, the ensemble method uses multiple learning algorithms to obtain better predictive performance over one meta-learning algorithm[15].

Bagging or Boosting methods can be used for this but the Stacking method generates better results on the project dataset[14].

So, the project consists of a Stacking ensemble method in irrigated land ML model which gives better results than any of the single algorithms.

2.4.2. Numpy: It is a well known general-purpose array-processing package.

An extensive collection of high complexity mathematical functions make NumPy powerful to process large multi-dimensional arrays and matrices.

NumPy is very useful for handling linear algebra, Fourier transforms, and random numbers.

2.4.3. Pandas: Pandas is a fast, powerful, flexible and easy to use open source data analysis and manipulation tool built on top of the Python programming language.

2.3.4. Pickle: The pickle module implements a fundamental, but

Similarity 13%

7 Amazing Machine learning Python Libraries for 2020 - DEV

numpy is very useful for handling linear algebra, fourier transforms, and random numbers. other libraries like tensorflow uses numpy attheano is based on numpy and is tightly integrated with numpy. the user interface is very similar. theano can work with graphics processors (gpu)...

https://dev.to/kris/7-amazing-machine-learning-python-libraries-for-2020-1e15

Similarity 9%

scikit-learn - Wikipedia

scikit-learn is largely written in python, and uses numpy extensively for high-performance linear algebra and array operations. furthermore, some core algorithms are written in cython to improve performance. support vector machines are implemented by a cython wrapper around libsvm...

https://en.wikipedia.org/wiki/Scikit-learn

Similarity 12%

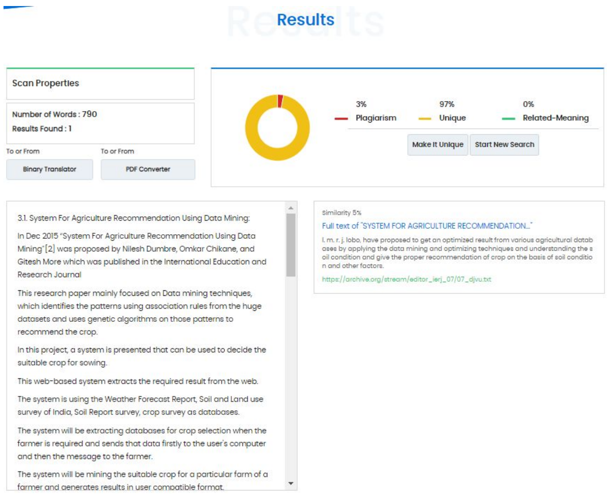
Matplotlib - Wikipedia

matplotlib is a plotting library for the python programming language and its numerical mathematics extension numpy. it provides an object-oriented api for embedding plots into applications...

https://en.wikipedia.org/wiki/Matplotlib

3. EXISTING SYSTEMS:

a.



Number of Words : 790

Results Found : 1

3% Plagiarism

97% Unique

0% Related-Meaning

3.1. System For Agriculture Recommendation Using Data Mining:

In Dec 2015 "System For Agriculture Recommendation Using Data Mining"[2] was proposed by Nilesh Dumbre, Omkar Chikane, and Gitesh More which was published in the International Education and Research Journal

This research paper mainly focused on Data mining techniques, which identifies the patterns using association rules from the huge datasets and uses genetic algorithms on those patterns to recommend the crop.

In this project, a system is presented that can be used to decide the suitable crop for sowing.

This web-based system extracts the required result from the web.

The system is using the Weather Forecast Report, Soil and Land use survey of India, Soil Report survey, crop survey as databases.

The system will be extracting databases for crop selection when the farmer is required and sends that data firstly to the user's computer and then the message to the farmer.

The system will be mining the suitable crop for a particular farm of a farmer and generates results in user compatible format.

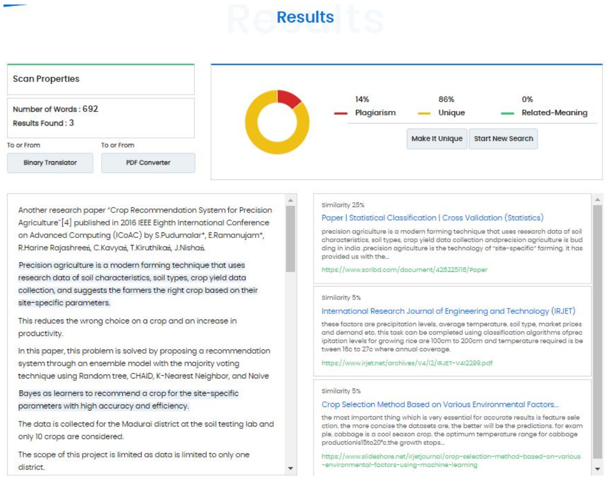
Similarity 5%

Full text of "SYSTEM FOR AGRICULTURE RECOMMENDATION..."

l. m. r. j. lobo, have proposed to get an optimized result from various agricultural databases by applying the data mining and optimizing techniques and understanding the soil condition and give the proper recommendation of crop on the basis of soil condition and other factors.

https://archive.org/stream/editor_ierj_07/07_djvu.txt

b.



Number of Words : 692

Results Found : 3

14% Plagiarism

86% Unique

0% Related-Meaning

Another research paper "Crop Recommendation System for Precision Agriculture"[4] published in 2016 IEEE Eighth International Conference on Advanced Computing (ICoAC) by S.Pudumalar*, E.Ramanujam*, R.Harine Rajashree#, C.Kavya#, T.Kiruthika#, J.Nisha#.

Precision agriculture is a modern farming technique that uses research data of soil characteristics, soil types, crop yield data collection, and suggests the farmers the right crop based on their site-specific parameters.

This reduces the wrong choice on a crop and an increase in productivity.

In this paper, this problem is solved by proposing a recommendation system through an ensemble model with the majority voting technique using Random tree, CHAID, K-Nearest Neighbor, and Naive

Bayes as learners to recommend a crop for the site-specific parameters with high accuracy and efficiency.

The data is collected for the Madurai district at the soil testing lab and only 10 crops are considered.

The scope of this project is limited as data is limited to only one district.

Similarity 25%

Paper | Statistical Classification | Cross Validation (Statistics)

precision agriculture is a modern farming technique that uses research data of soil characteristics, soil types, crop yield data collection andprecision agriculture is budding in india .precision agriculture is the technology of "site-specific" farming. it has provided us with the...

https://www.scribd.com/document/426225116/Paper

Similarity 5%

International Research Journal of Engineering and Technology (IRJET)

these factors are precipitation levels, average temperature, soil type, market prices and demand etc. this task can be completed using classification algorithms ofprecipitation levels for growing rice are 100cm to 200cm and temperature required is between 16c to 27c where annual coverage.

https://www.irjet.net/archives/V4/i2/IRJET-V4I2299.pdf

Similarity 5%

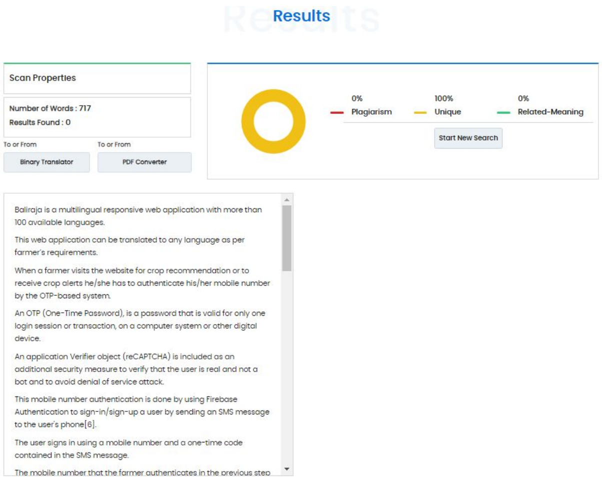
Crop Selection Method Based on Various Environmental Factors...

the most important thing which is very essential for accurate results is feature selection. the more concise the datasets are, the better will be the predictions. for example, cabbage is a cool season crop. the optimum temperature range for cabbage productionis15to20°c.the growth stops...

https://www.slideshare.net/irjetjournal/crop-selection-method-based-on-various-environmental-factors-using-machine-learning

4. METHODOLOGY:

a.



Scan Properties

Number of Words : 717

Results Found : 0

Baliraja is a multilingual responsive web application with more than 100 available languages.

This web application can be translated to any language as per farmer's requirements.

When a farmer visits the website for crop recommendation or to receive crop alerts he/she has to authenticate his/her mobile number by the OTP-based system.

An OTP (One-Time Password), is a password that is valid for only one login session or transaction, on a computer system or other digital device.

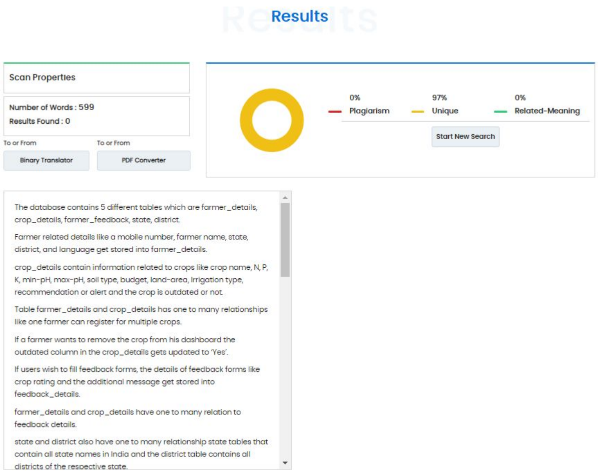
An application Verifier object (reCAPTCHA) is included as an additional security measure to verify that the user is real and not a bot and to avoid denial of service attack.

This mobile number authentication is done by using Firebase Authentication to sign-in/sign-up a user by sending an SMS message to the user's phone[6].

The user signs in using a mobile number and a one-time code contained in the SMS message.

The mobile number that the farmer authenticates in the previous step

b.



Scan Properties

Number of Words : 599

Results Found : 0

The database contains 5 different tables which are farmer_details, crop_details, farmer_feedback, state, district.

Farmer related details like a mobile number, farmer name, state, district, and language get stored into farmer_details.

crop_details contain information related to crops like crop name, N, P, K, min-pH, max-pH, soil type, budget, land-area, Irrigation type, recommendation or alert and the crop is outdated or not.

Table farmer_details and crop_details has one to many relationships like one farmer can register for multiple crops.

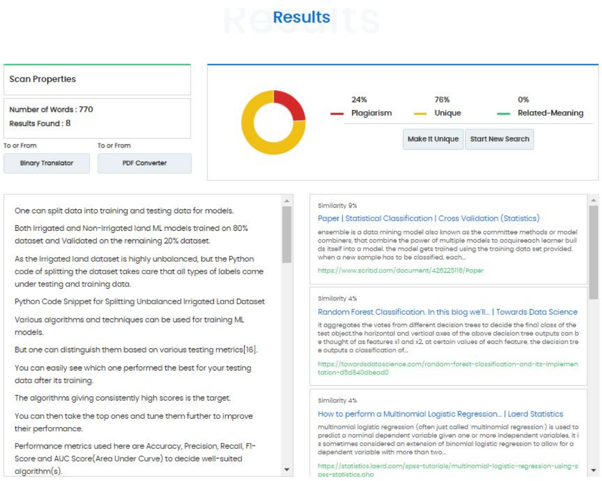
If a farmer wants to remove the crop from his dashboard the outdated column in the crop_details gets updated to 'Yes'.

If users wish to fill feedback forms, the details of feedback forms like crop rating and the additional message get stored into feedback_details.

farmer_details and crop_details have one to many relation to feedback details.

state and district also have one to many relationship state tables that contain all state names in India and the district table contains all districts of the respective state.

c.



Scan Properties

Number of Words : 770

Results Found : 8

One can split data into training and testing data for models.

Both Irrigated and Non-Irrigated land ML models trained on 80% dataset and Validated on the remaining 20% dataset.

As the Irrigated land dataset is highly unbalanced, but the Python code of splitting the dataset takes care that all types of labels come under testing and training data.

Python Code Snippet for Splitting Unbalanced Irrigated Land Dataset

Various algorithms and techniques can be used for training ML models.

But one can distinguish them based on various testing metrics[16].

You can easily see which one performed the best for your testing data after its training.

The algorithms giving consistently high scores is the target.

You can then take the top ones and tune them further to improve their performance.

Performance metrics used here are Accuracy, Precision, Recall, F1-Score and AUC Score(Area Under Curve) to decide well-suited algorithm(s).

Similarity 9%

Paper | Statistical Classification | Cross Validation (Statistics)

ensemble is a data mining model also known as the committee methods or model combiners, that combine the power of multiple models to acquireeach learner builds itself into a model. the model gets trained using the training data set provided. when a new sample has to be classified, each...

https://www.scribd.com/document/426225116/Paper

Similarity 4%

Random Forest Classification. In this blog we'll... | Towards Data Science

it aggregates the votes from different decision trees to decide the final class of the test object.the horizontal and vertical axes of the above decision tree outputs can be thought of as features x1 and x2. at certain values of each feature, the decision tree outputs a classification of...

https://towardsdatascience.com/random-forest-classification-and-its-implementation-d5d840dbead0

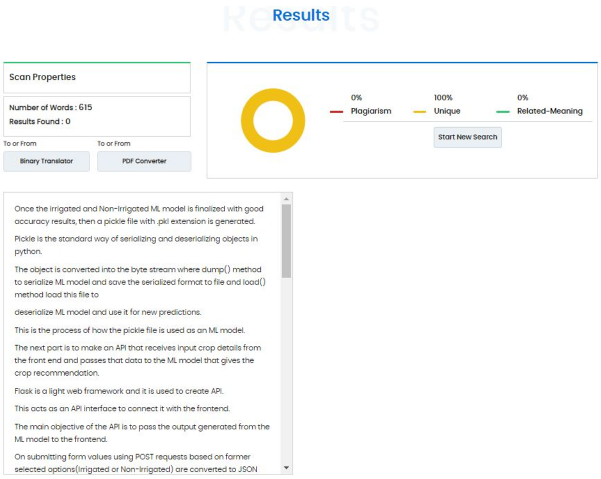
Similarity 4%

How to perform a Multinomial Logistic Regression... | Laerd Statistics

multinomial logistic regression (often just called 'multinomial regression') is used to predict a nominal dependent variable given one or more independent variables. it is sometimes considered an extension of binomial logistic regression to allow for a dependent variable with more than two...

https://statistics.laerd.com/spss-tutorials/multinomial-logistic-regression-using-spss-statistics.php

d.



Scan Properties

Number of Words : 615

Results Found : 0

Once the irrigated and Non-Irrigated ML model is finalized with good accuracy results, then a pickle file with .pkl extension is generated.

Pickle is the standard way of serializing and deserializing objects in python.

The object is converted into the byte stream where dump() method to serialize ML model and save the serialized format to file and load() method load this file to

deserialize ML model and use it for new predictions.

This is the process of how the pickle file is used as an ML model.

The next part is to make an API that receives input crop details from the front end and passes that data to the ML model that gives the crop recommendation.

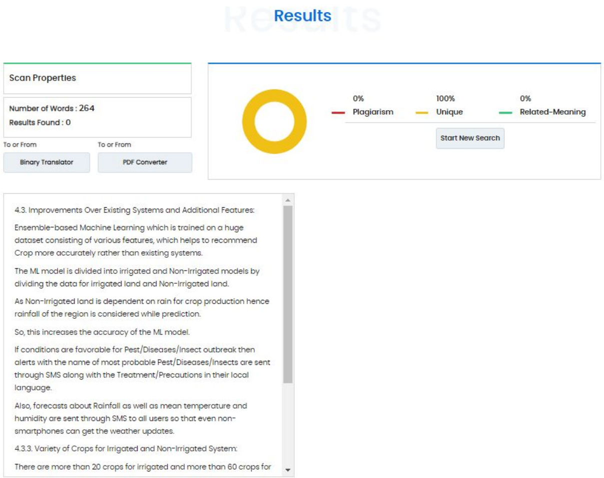
Flask is a light web framework and it is used to create API.

This acts as an API interface to connect it with the frontend.

The main objective of the API is to pass the output generated from the ML model to the frontend.

On submitting form values using POST requests based on farmer selected options(Irrigated or Non-Irrigated) are converted to JSON

e.



Scan Properties

Number of Words : 264

Results Found : 0

4.3. Improvements Over Existing Systems and Additional Features:

Ensemble-based Machine Learning which is trained on a huge dataset consisting of various features, which helps to recommend Crop more accurately rather than existing systems.

The ML model is divided into irrigated and Non-Irrigated models by dividing the data for irrigated land and Non-Irrigated land.

As Non-Irrigated land is dependent on rain for crop production hence rainfall of the region is considered while prediction.

So, this increases the accuracy of the ML model.

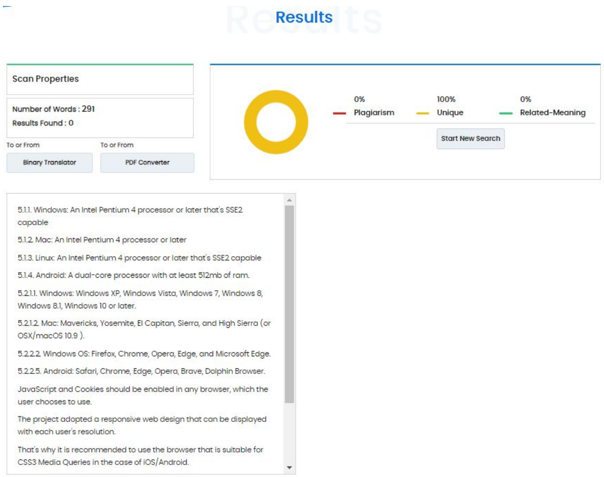
If conditions are favorable for Pest/Diseases/Insect outbreak then alerts with the name of most probable Pest/Diseases/Insects are sent through SMS along with the Treatment/Precautions in their local language.

Also, forecasts about Rainfall as well as mean temperature and humidity are sent through SMS to all users so that even non-smartphones can get the weather updates.

4.3.3. Variety of Crops for Irrigated and Non-Irrigated System:

There are more than 20 crops for irrigated and more than 60 crops for

5. DEPENDENCIES AND REQUIREMENTS:



Number of Words : 291
Results Found : 0

0% Plagiarism
100% Unique
0% Related-Meaning

5.1.1. Windows: An Intel Pentium 4 processor or later that's SSE2 capable

5.1.2. Mac: An Intel Pentium 4 processor or later

5.1.3. Linux: An Intel Pentium 4 processor or later that's SSE2 capable

5.1.4. Android: A dual-core processor with at least 512mb of ram.

5.2.1.1. Windows: Windows XP, Windows Vista, Windows 7, Windows 8, Windows 8.1, Windows 10 or later.

5.2.1.2. Mac: Mavericks, Yosemite, El Capitan, Sierra, and High Sierra (or OSX/macOS 10.9).

5.2.2.2 Windows OS: Firefox, Chrome, Opera, Edge, and Microsoft Edge.

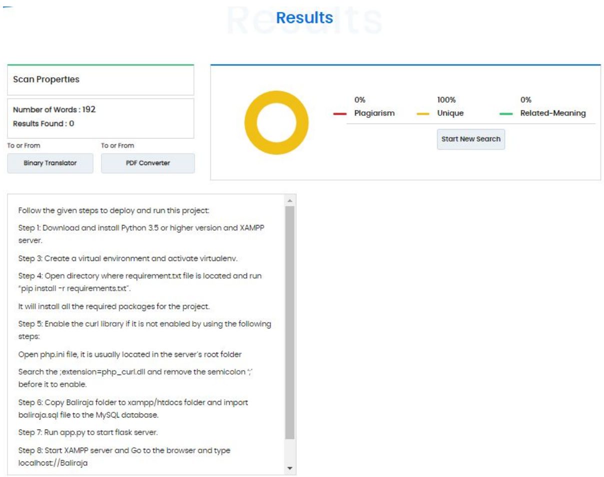
5.2.2.5. Android: Safari, Chrome, Edge, Opera, Brave, Dolphin Browser.

JavaScript and Cookies should be enabled in any browser, which the user chooses to use.

The project adopted a responsive web design that can be displayed with each user's resolution.

That's why it is recommended to use the browser that is suitable for CSS3 Media Queries in the case of iOS/Android.

6. INSTRUCTIONS FOR DEPLOYMENT:



Number of Words : 192
Results Found : 0

0% Plagiarism
100% Unique
0% Related-Meaning

Follow the given steps to deploy and run this project:

Step 1: Download and install Python 3.5 or higher version and XAMPP server.

Step 3: Create a virtual environment and activate virtualenv.

Step 4: Open directory where requirement.txt file is located and run "pip install -r requirements.txt".

It will install all the required packages for the project.

Step 5: Enable the curl library if it is not enabled by using the following steps:

Open php.ini file, it is usually located in the server's root folder

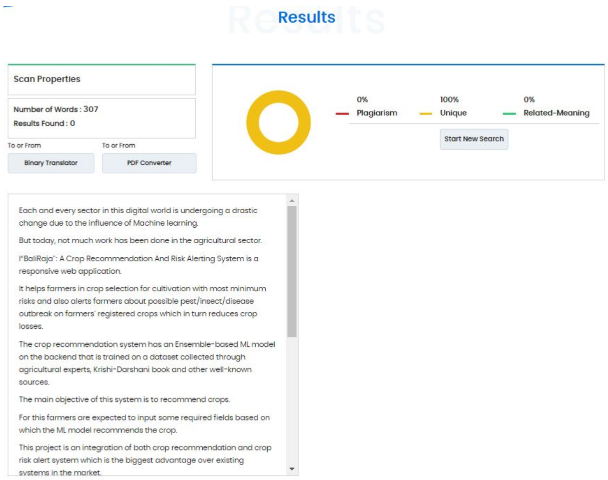
Search the ;extension=php_curl.dll and remove the semicolon ';' before it to enable.

Step 6: Copy Baliraja folder to xampp/htdocs folder and import baliraja.sql file to the MySQL database.

Step 7: Run app.py to start flask server.

Step 8: Start XAMPP server and Go to the browser and type localhost://Baliraja

7. SUMMARY:



Number of Words : 307
Results Found : 0

0% Plagiarism
100% Unique
0% Related-Meaning

Each and every sector in this digital world is undergoing a drastic change due to the influence of Machine learning.

But today, not much work has been done in the agricultural sector.

I"BaliRaja": A Crop Recommendation And Risk Alerting System is a responsive web application.

It helps farmers in crop selection for cultivation with most minimum risks and also alerts farmers about possible pest/insect/disease outbreak on farmers' registered crops which in turn reduces crop losses.

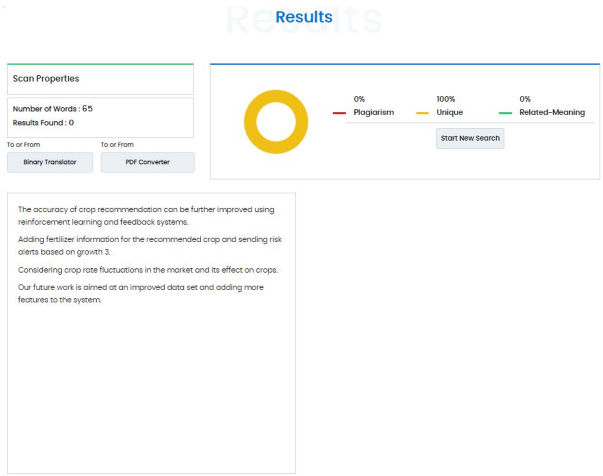
The crop recommendation system has an Ensemble-based ML model on the backend that is trained on a dataset collected through agricultural experts, Krishi-Darshani book and other well-known sources.

The main objective of this system is to recommend crops.

For this farmers are expected to input some required fields based on which the ML model recommends the crop.

This project is an integration of both crop recommendation and crop risk alert system which is the biggest advantage over existing systems in the market.

8. FUTURE SCOPE:



Number of Words : 65
Results Found : 0

0% Plagiarism
100% Unique
0% Related-Meaning

The accuracy of crop recommendation can be further improved using reinforcement learning and feedback systems.

Adding fertilizer information for the recommended crop and sending risk alerts based on growth 3.

Considering crop rate fluctuations in the market and its effect on crops.

Our future work is aimed at an improved data set and adding more features to the system.

Overall plagiarism check is :
((100+100+100+75+67+86+78+97+86+100+100+76+100+100+100+100+100+100)/1800)*100
=(1665/1800)*100
=0.925*100
=92.5
So, after the plagiarism test, **Overall uniqueness of the report is 92.5%.**

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GROUP PHOTO

Github URL: https://github.com/416121jokarem/BaliRaja