International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 10 No. 6s, 2024
https://theaspd.com/index.php

Artificial Intelligence In Agriculture (AIA) To Predictive Analysis For Crop Suitability And Fertilizer Efficiency

Muneshwara M S[1], Swetha M S[2], Anand R[3], G. Jai Arul Jose[4], Shivakumara T[5], Kallur V Vijayakumar[6], Chethan A.S[7] and Lokesh.A[8]
[1]Department of CSE, BMSIT&M, Yelahanka, Bengaluru, Karnataka India
[2]Department of ISE, BMSIT&M, Yelahanka, Bengaluru, Karnataka India
[3]Department of CSE, BMSIT&M, Yelahanka, Bengaluru, Karnataka India
[4]Department of CSE, BMSIT&M, Yelahanka, Bengaluru, Karnataka India
[5]Departmentof MCA, BMSIT&M, Yelahanka, Bengaluru, Karnataka India
[6,7]Department of Mathematics, BMSIT&M, Yelahanka, Bengaluru, Karnataka India
[8]Department: AI&ML, SEA College of Engineering and Technology, KR Puram, Bengaluru, Karnataka
[1]muneshwarams@bmsit.in, [2]swethams_ise2014@bmsit.in,[3]anandor@bmsit.in, [4]aruljose@bmsit.in, [5]shivakumarat@bmsit.in, [6]kallurvijayakumar@bmsit.in ,[7]aschethan@bmsit.in and [8]lokeshyadav.ka@gmail.com
[1]https://orcid.org/0000-0003-4714-4100 and [2]https://orcid.org/0000-0002-6669-1372, [4]https://orcid.org/0000-0002-6131-9643, [5]https://orcid.org/0000-0002-5213-0953, [6]https://orcid.org/0000-0002-7205-1144 and [7]https://orcid.org/0000-0002-7002-9349

Abstract: *The principal objective of this article is to cultivate an all-encompassing solution for addressing diverse challenges in the agricultural sector. With the rising prominence of Machine Learning, which involves enabling machines to create educated results founded on provided datasets, integration of this expertise plays a crucial part in achieving paper goals. Specifically, the initiative emphases on guessing the most appropriate crops for farming based on land conditions and determining the optimal fertilizer quantities considering weather patterns and farming practices. This system seeks to replace the traditional, manual, and often imprecise methods used by farmers, empowering them to make data-driven decisions that result in enhanced agricultural productivity and yields.*
Keywords: *AI, Bigdata, Crop , IoT, Temperature,*

1. INTRODUCTION

In India, traditional farming methods are still predominantly used, where crops are cultivated without sufficient knowledge of soil composition and quality. Consequently, farmers often fail to achieve optimal yields and profits. The current soil testing process is primarily manual, involving the collection of soil samples that are sent to laboratories for analysis. This method is not only time-consuming but also less practical, as it introduces the possibility of human errors, which can result in inaccurate reports for farmers. To address these challenges, there is a pressing need for an automatic system for earth analysis and crop expectation. Soil testing is crucial for determining soil fertility, which in turn aids in identifying the most suitable crops. We propose a system incorporating a handheld device capable of measuring pH levels, along with the estimation of Nitrogen (N), Phosphorus (P), and Potassium (K) content using factors such as pH, temperature, moisture, and electrical conductivity.

India, an agriculturally driven country, has nearly 50% of its workforce engaged in farming-related activities and contributes 7.68% to the worldwide agricultural output. Its cultivated sector's involvement to the nationwide economy surpasses global middling of 6.1%. Yet, outdated farming rehearses in India result in little each capita output and agriculturalist profits. These methods demand significant manual effort for tasks such as irrigation, cultivation, and pesticide application. Soil analysis is a vital technique for assessing nutrient levels, including NPK, temperature, moisture, and electrical conductivity. By automating the soil testing process and employing sensors to monitor soil quality, labor-intensive efforts can be lessened, prominent to improved efficiency and accuracy in farming does.

2. LITERATURE SURVEY

A four-step methodology for soil analysis and crop prediction is presented in [1]. The first step involves obtaining soil parameters, including moisture, temperature, and pH, via sensors like FC-28, DS18B20, and a nonspecific soil pH sensor. The next step is the design and deployment of a controlled ML algorithm to establish relationships between training and target attributes, enabling classification and prediction of new inputs. In the third step, collected and measured data is processed to identify a proper crop diversity. Finally, the last step provides fertilizer recommendations based on soil analysis results, crop nutrient needs, and field moisture conditions.

In [2], the authors introduced an smart scheme called *Agroconsultant* that leverages Big Data Analytics and Machine Learning to assistance growers in production well-versed conclusions regarding crop cultivation. The system uses a crop suitability predictor, which incorporates characteristics such as soil category, aquifer viscosity, soil-pH, topsoil depth, precipitation, temperature, and geographical position. Missing data points are replaced with large negative values during preprocessing, and class labels are assigned based on production-to-area ratios. Multi-labeled classification algorithms train the system to handle instances with multiple possible labels. A rainfall prediction sub-system is also included, which forecasts monthly rainfall for specific states.

The study in [3] emphases on predicting the essential N-P-K content in the soil using a random forest algorithm. It comprises the growth of a active wweb interface to assistance farmers. The approach starts with gathering N-P-K datassets, which are recycled to train a randomm forestt-based classificatiion model. The implementation employs R Shiny for testing and classification, consisting of two components: *ui.R*, which serves as the client-side interface for inputting values like obtainable N-P-K, soil kind, crop category, & aim produce, and *server.R*, a cloud-baased data analytics server. The server hosts the random forest algorithm, integrates ICAR (Indian Council of Agricultural Research) data, and generates location-specific maps using ggmap.

In [4], the authors employ data-mining techniques to develop a predictive model for soil fertility analysis. Using decision tree classification methods, the J48 algorithm is adopted after evaluating various data-mining approaches based on accuracy and error rates. This algorithm achieves an accuracy of 91.90%, which is further enhanced to 93.20% by selecting relevant attributes and reducing redundancies. Additional boosting techniques increase the model's accuracy to 96.73%. These refinements are executed by means of the WEKA (Waikato Environment for Knowledge Analysis) tool.

The work in [6] proposes a dual-module system for soil productiveness analysis and crop recommendation. The first module evaluates the soil's micro and worldwide nutrient gratified to provide farmers with a comprehensive understanding of soil characteristics. This module applies regression algorithms alongside gradient descent and calculates the rooot mean squar error between foreseen and observed values. The second module recommends crops based on soil kind and overall nutrient contented, optimizing harvest potential.

In [7], an efficient machine learning model is designed to improve soil fertility prediction accuracy. The methodology starts with collecting soil data and preprocessing it to eliminate missing ideals and noise. Data mining techniques are then applied to the processed datasets. The study identifies the C5.0 model as the most effective classification technique, achieving an correctness rate of 96%. The model segments data based on fields with the highest information gain and iteratively refines subsamples until further division is unnecessary. These subsamples are then categorized into appropriate groups, enabling accurate predictions of soil fertility and suitable crop recommendations.

2.1. Motivation

Based on the findings of various articles with regards to reduced crop yield, it is quite clear that the reason for the same is lack of efficient and accurate information about soil content and the consequent benefits of bringing up the best suitable crop. This has resulted in huge loss for the farmers who are currently the backbone of India.

After thorough research on previous existing systems, we have taken note of the following limitations which were the key points considered in the paper.

- Existing systems provide reports and results based on the values acquired from a maximum of not more than two contributing factors of soil fertility. Though based on those factors the results may be accurately calculated, there may be various other factors that hold higher weightage on soil fertility determination.
- The consideration that the farmers may not be able to comprehend or easily understand the result being given due to possible educational and linguistic barriers has not been accounted for.
- Lengthy and time-consuming lab procedures for chemical testing.

- Analysis of attained results not provided.
- In depth focus on only individual aspects of the soil.
- Human errors introduced due to manual work.
- Results are complex and difficult to comprehend.

2.2. Problem Statement

The 21st century has seen enormous amount of automation and technological advancements taking over every field of business but the field of agriculture has fallen behind in the race. For a better and more profitable crop yield, the traditional methodology adopted must be automated that guarantee accuracy and fact-based results. Additionally, making sure that these results are communicated through audio makes it even more convenient.

2.3. Scope

- The system will calculate the fertility of the soil presented as input by calculating various factors such as Temperature, moisture, NPK (Nitrogen, Phosphorous Potassium).
- Based on the quality of the soil, the system will predict the most suitable crop for the soil by applying classification and prediction algorithms
- The system will also calculate and output the amount of fertilizer to be used for ideal harvest of the selected crop based on the selected crop and various soil factors.

2.5 Challenges

The challenges faced during the entire process of the system are as follows:

- Developing and choosing an efficient Machine learning algorithm that correctly assess the input for determining the fertility and various other factors of given soil sample.
- Gathering and considering of all components and characteristics of soil to predict proper and accurate results.
- Studying the already predicted data-sets of the calculated results of tested soil samples covering all the regions where the software is being put into use.
- Making the farmers learn to properly use the devices and sensors that read the soil samples.
- Choosing the most accurate devices to read the soil sample to read data such as pH.
- Educating the industry about the birth and presence of the software being developed.
- Updating the software regularly in-order to provide the most accurate results.

3. overview proposed of system architecture

The 21st century has seen enormous amount of automation and technological advancements taking over every field of business but the field of agriculture has fallen behind in the race. For a better and more profitable crop yield, the traditional methodology adopted must be automated that guarantee accuracy and fact-based results.

The central objective of the planned system is to introduce automation in the field of agriculture, which is asking for major attention at this time frame. In countries like India, most of the farmers are unaware of the modern methods and techniques of farming and still follow the old and un- automated methodology which results in poor crop yield and thus lower net profit for the people who provide food for all.

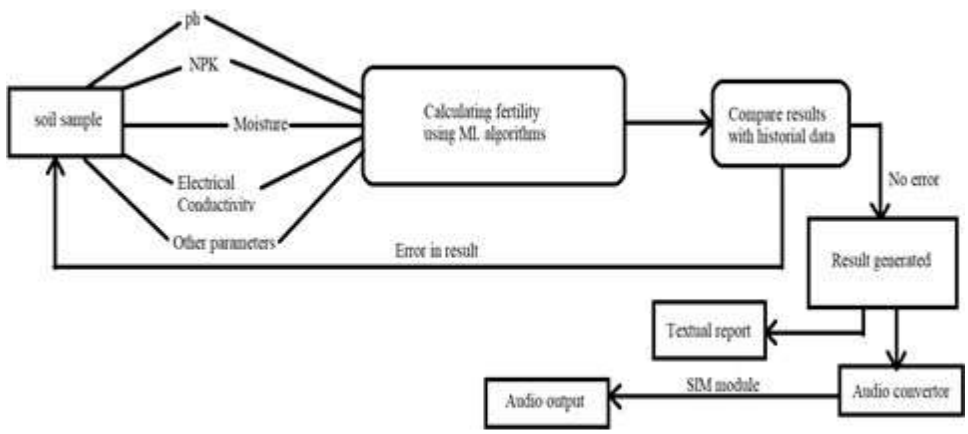


Figure 1: Proposed System Architecture

The IoT is a structure of interconnected calculating procedures, motorized and digital machines providing with exceptional identifiers and the capacity to transmission data over a network deprived of needing humane-to-humane or humane-to-computerr interaction. In the IoT model used for the system, we make use of three sensors to detect the following.

- Temperature
- Moisture
- Electrical Conductivity

Testing of the soil sample is to be done by the sensors and the measured values from the sensors are directed to an IoT device that needs to be processed. The NPK and Ph values of the soil sample are extracted manually.

4. System Detailed Design

The detailed design of the system is given below:

4.1 System Architecture and Design

System construction is a conceptual model that defines the structure, behavior and more views of a system. A system architecture can comprise system components, the expand system developed, that will work together the overall system.

We have divided the architecture into 3 different phases:

❖ **Internet of Things (IoT) model**

In this phase we come across different sensors which include NPK, pH, temperature, moisture, electric conductivity sensors which helps in reading the live data from the soil which is to include IoT device built using an Arduino. IoT is a system of unified calculating devices, mechanical and digital machines provided with single identifiers and the skill to transferal data over a network deprived of requiring humane-to-humane or humane- to-computer interactionn. Hence the values captured by the sensor,s placed in the soil are directly sent to the software for analysis.

❖ **Prediction Model**

In this phase we use three different machine learning algorithms to predict which crop is suitable to grow in the soil being tested, the algorithms used are Naive Bayes Classifier algorithm, k-Nearest-Neighbor algorithm and Random Forest. These algorithms are known to result in a set of high probability matches or crop varieties, hence the crops which occur a higher number of times is selected as most suitable.

❖ **Data Analytics**

Reducing the resultant crop varieties to a single ideal variety that assures profitable yield, this phase work on our datasets and by taking the results of each algorithm we predict a final answer. Additional constraints are also applied at this at this stage to further narrow down possibilities.

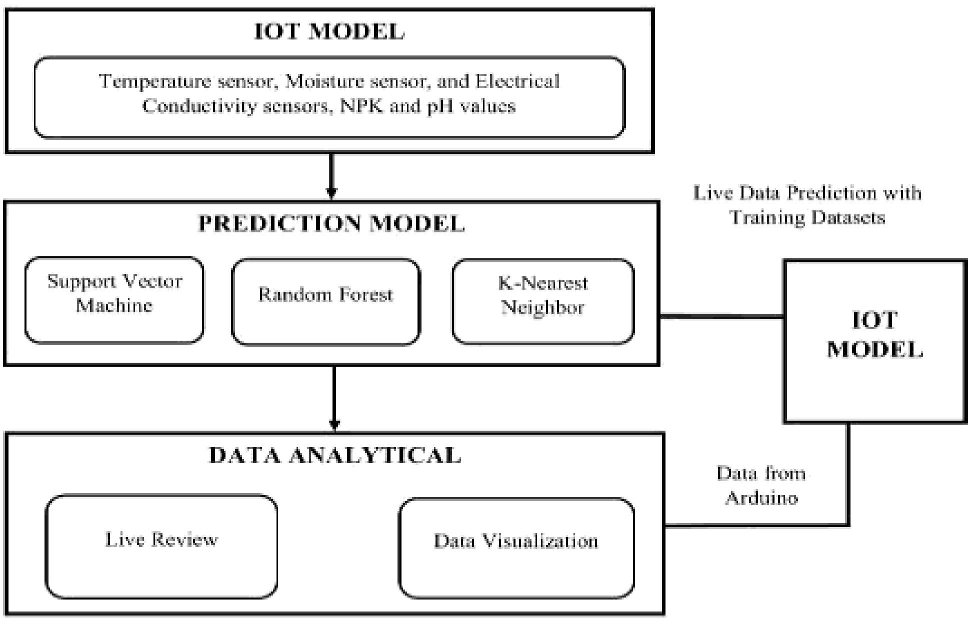


Figure 2: System architecture

Figure 2. lays out the system architecture for the paper. The IoT model consist of Temperature sensor,

moisture sensor, and electric conductivity sensors and NPK and Ph values. The three algorithms used for prediction model is K-NN, Random Forest and SVM. By using this we can predict with training dataset, and data analytical is nothing but a live review and data visualization from Arduino from IoT model.

4.2. Flowchart Diagram

A flowchart is one of the basic quality tools used in system management and it displays the actions that are necessary to meet the goals of a particular task in the most practical sequence. Also called as process maps, this type of tool displays a series of steps with branching possibilities that depict one or more inputs and transforms them to outputs.

In this paper, data is collected from the IoT model and that data is preprocessed using the dataset. The crop model creation is done by applying three machine learning algorithms based on their accuracy is classification and regression. A model is created and analysis of retrieved data is done. The crop prediction model developed accurately predicts the crop to be cultivated in the tested soil and the fertilizer prediction model developed predicts the amount of fertilizer needed by the soil.

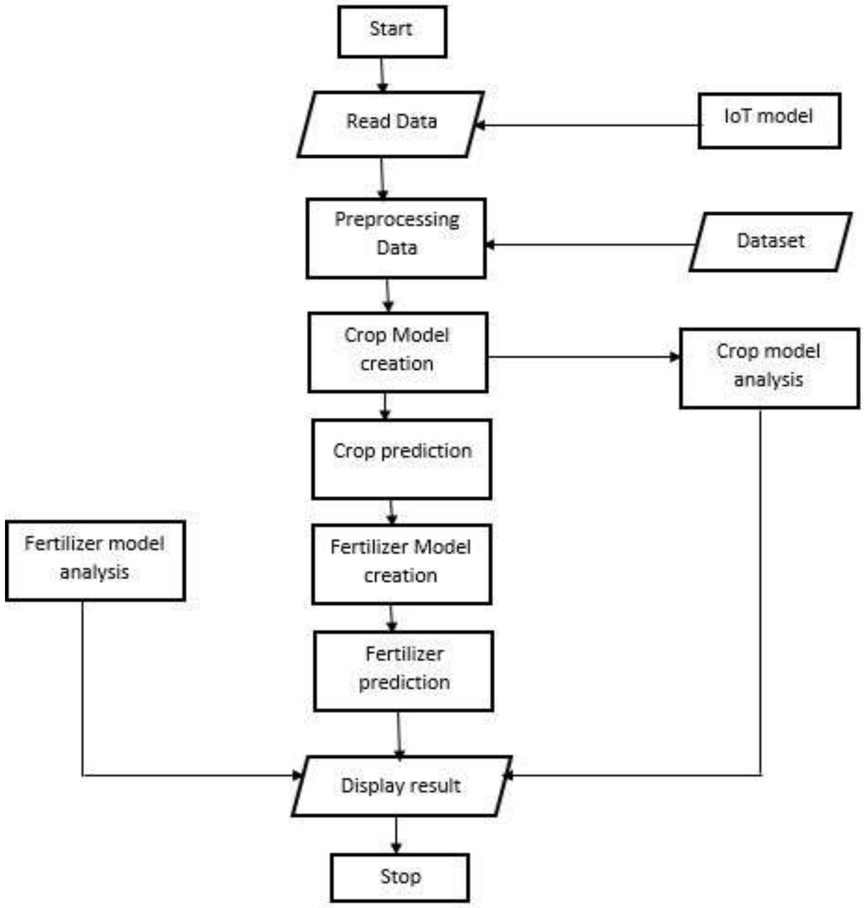


Figure 3: Flow chart

4.3 Sequence Diagram

A sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. In this paper User produces the soil sample to be tested as input to the sensor. The sensors used are able to measure values such as temperature, moisture, electrical conductivity. Additionally, the NPK and pH value is manually added and together all attributes and their respective values are delivered to the IoT ideal. The Archetypal is a collection of data sets required to aid in the prediction of crop variety and fertilizer amount. It consists of historical data of previously tested soil samples and other research findings. This data set creates the model which is processed together with the sensor-retrieved soil values. Applying the multiple algorithms to increase accuracy, a prediction is made on the most suitable crop for the given soil sample along with the fertilizer requirement for the crop.

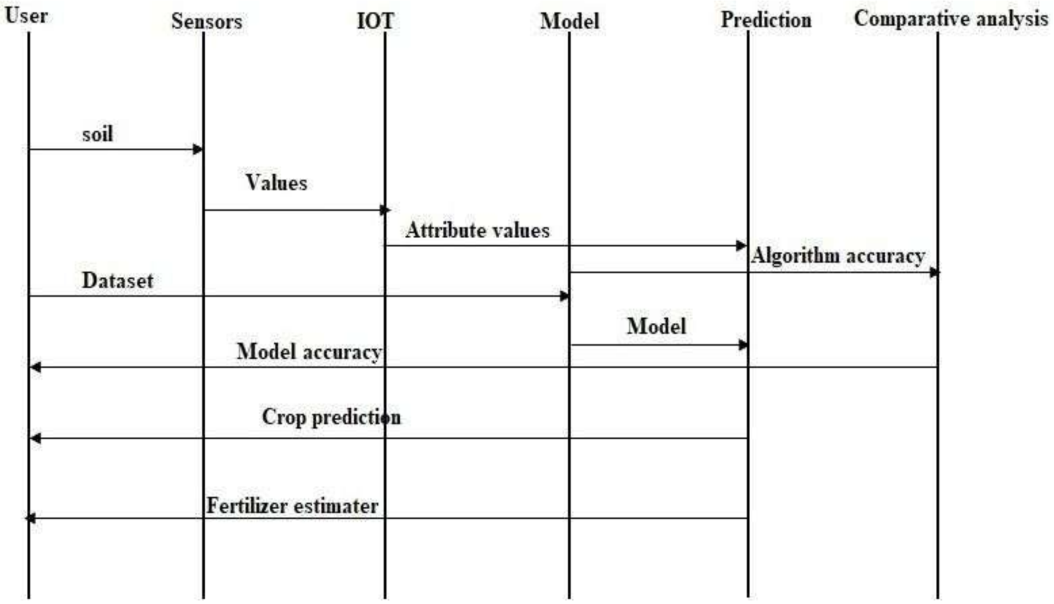


Figure 4: Sequence diagram

5. System Implementation

The three algorithms used to accurately make a decision on the type of crop to cultivate are mentioned below:

5.1. K-Nearest Neighbor (KNN)

K-Naearest Neighbor is 1 of the humblest ML algorithms based on Supervised Knowledge practice.

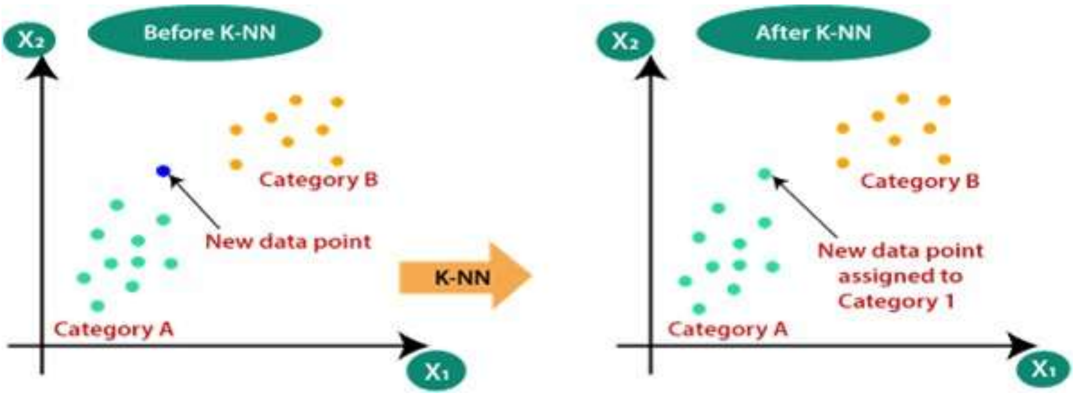


Figure 5: K-Nearest Neighbor

Supposing we take a novel data fact and essential to place it in the essential category. Ruminate the underneath carbon copy:

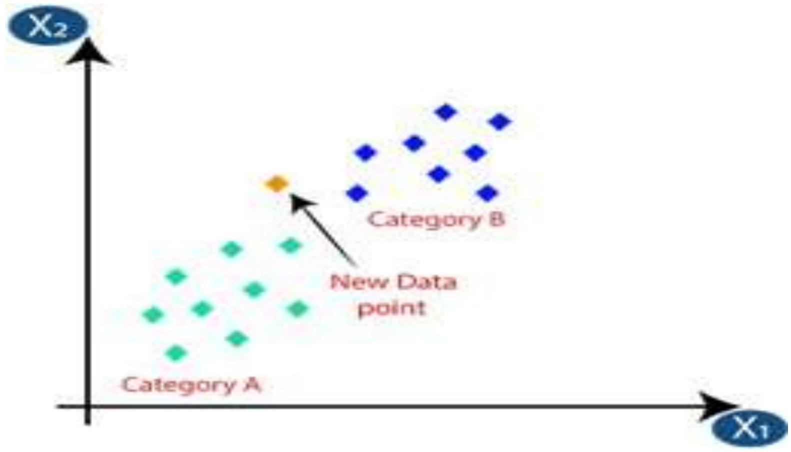
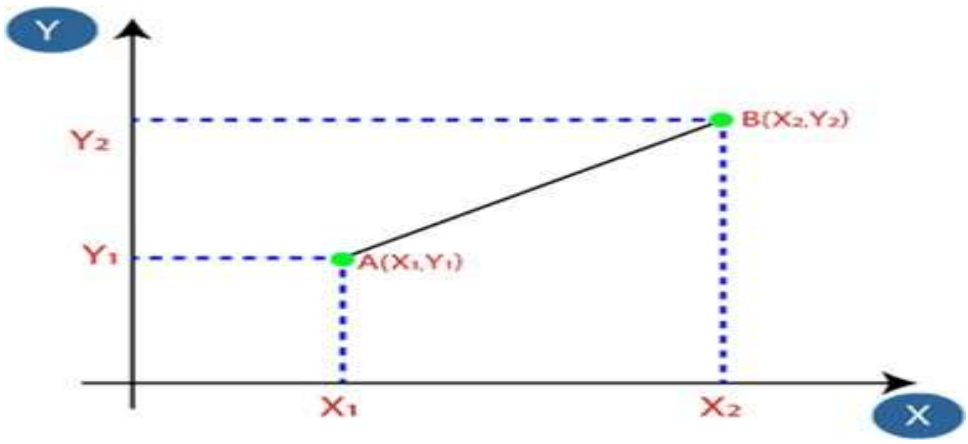


Figure 6: KNN Classification



:

Figure 7: KNN Euclidean Distance

5.2 Random Forest

Random forestts or random choice forests are a collaborative knowledge technique for organization, reversion and additional errands that operates by building a crowd of decision trees at exercise period and outtputting the lesson that is the manner of the mean prediction of the separate trees.

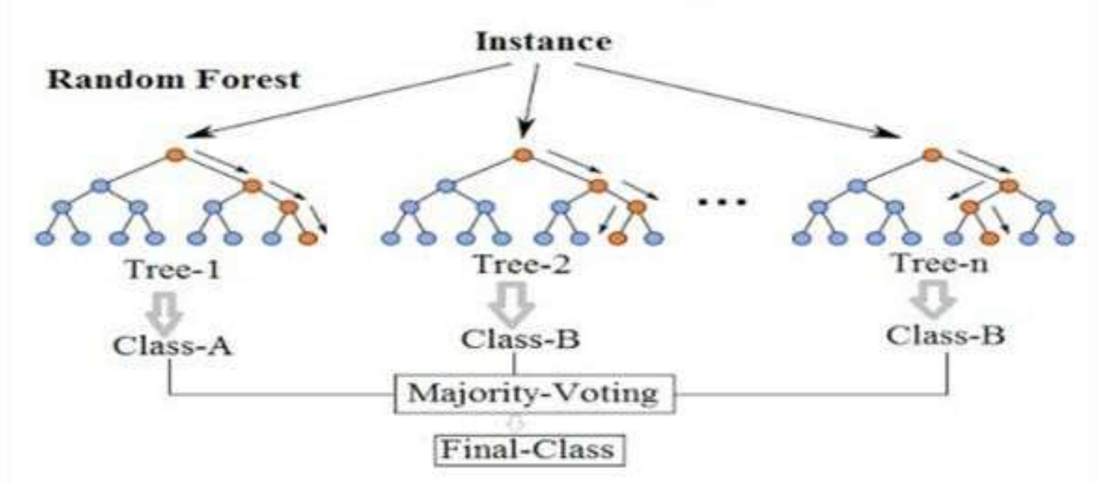


Figure 8: Simplified Random Forest

Each separate tree in the random forest sputa ready a class guess and the class with the utmost polls suits our model's estimate as shown in Figure 5.5.

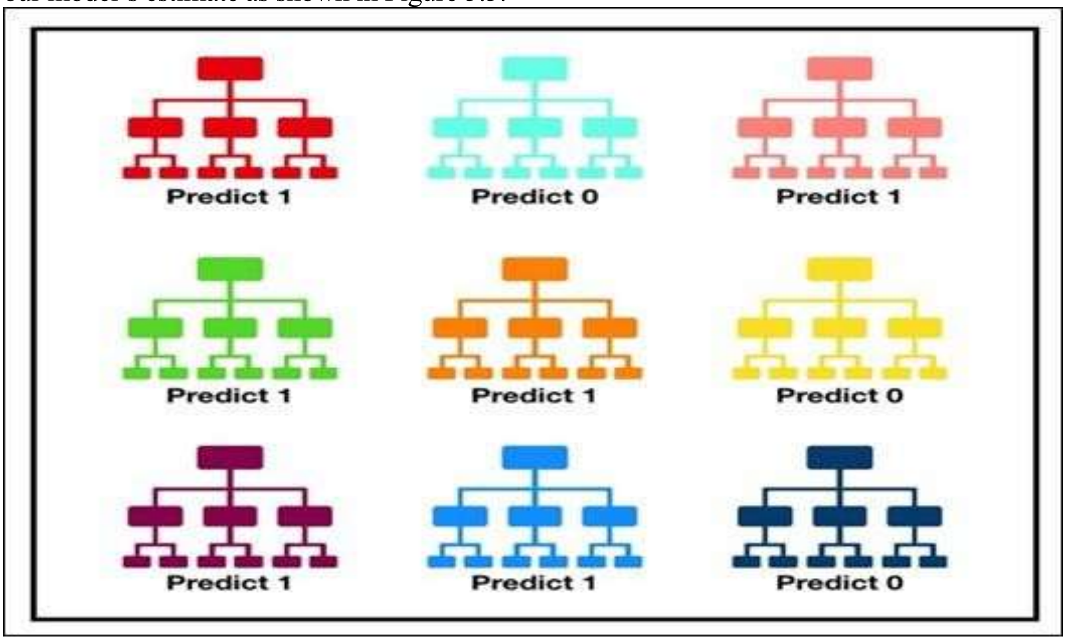


Figure 9: Visualization of a Random Forest Model Making a Prediction

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 10 No. 6s, 2024
https://theaspd.com/index.php

5.3 Model of the System

Various models of the systme are given below:

❖ **IoT Model**

In this IoT model we use 3 sensors to detect the following:

- Temperature
- Moisture
- Electric conductivity

Testing of the soil sample is to be done by the sensors and the measured values are sent to an IoT device to be processed. The NPK and Ph values of the soil sample are extracted manually.

	N	P	K	PH	Crop	moisture	temp
1989	59	59	76	5.98	com_paddy	29	23
1990	61	60	76	6.2	com_paddy	43	23
1991	61	57	72	8.45	com_paddy	29	18
1992	61	58	75	8.85	com_paddy	37	18
1993	58	58	74	5.55	com_paddy	27	22
1994	58	57	72	6.77	com_paddy	31	19
1995	59	61	72	6.5	com_paddy	30	18
1996	61	60	72	7.37	com_paddy	32	23
1997	59	60	72	7.28	com_paddy	45	21
1998	60	61	76	8.12	com_paddy	27	18
1999	61	59	74	5.97	com_paddy	32	22
2000	39	38	73	5.39	cotton_jowra	70	30
2001	37	40	73	6.25	cotton_jowra	73	29
2002	41	39	72	8.39	cotton_jowra	87	28
2003	39	37	75	5.11	cotton_jowra	86	24
2004	41	38	75	8.68	cotton_jowra	77	28
2005	37	37	72	5.47	cotton_jowra	72	27
2006	38	40	73	7.64	cotton_jowra	84	21
2007	41	37	76	6.1	cotton_jowra	73	25
2008	40	38	74	5.37	cotton_jowra	82	27
2009	40	41	72	5.18	cotton_jowra	78	24
2010	41	39	74	8.57	cotton_jowra	70	29
2011	38	41	76	8.16	cotton_jowra	82	29
2012	37	38	76	5.88	cotton_jowra	76	24

Figure 10: Sample of data set used

❖ **Crop Model Creation**

After the implementation of three algorithms namely Random forest, KNN, and Naïve Bayes, we select the algorithm with the maximum correctness to train and create the perfect. Prototypical construction once complete, is followed by model training. We were able to build models which take our data. Split the dataset into train and test dataset. Finally, we will build and train the prototypical using keep fit dataset. and the attribute used for the model creation are NPK, pH, moisture, temperature, and electric conductivity. By using this we predict the crop most suitable for cultivation.

❖ **Fertilizer Estimator Model Creation**

Similarly, for the development of the fertilizer estimator model, the candidate algorithm with the highest accuracy rate is chosen to train and create a model. The attributes used for model creation include NPK, pH, moisture, temperature, electrical conductivity and crop variety. Through this we are able to estimate the amount fertilizer needed.

❖ **Model Analysis**

Algorithm castoff in this broadsheet are Naive Bayes, Random Forest and KNN in which It has the model accuracy, and visualization part

6. System Testing

The aim of testing phase is to discover defects or errors by testing individual program components. During a system testing, these components are integrated to form a complete system. At this stage, testing was focused on establishing that the system met its functional requirements, and does not behave in an unexpected way. Test data were inputs which had been devised to test the system and the outputs were predicted from these inputs if the system operates according to its specification. Testing was done to examine the behavior in a cohesive system. The test cases were selected to ensure that the system behavior can be examined in all possible combination of conditions.

Accordingly, the expected behavior of the system under different combinations were given. Therefore, test cases were selected which had inputs and the outputs were on expected lines. Inputs that were not valid and for which suitable messages had to be given and the inputs that did not occur frequently were regarded as special cases.

6.1 Test Environment

A testing atmosphere is a arrangement of software and hardware on which the challenging team is going to perform the testing of the newly built software product. This setup consists of the physical setup which includes hardware, and logical setup that includes Server Operating system, client operating system, database server, front end running environment, browser (if web application), or any other software components required to run this software product. This testing setup is to be built on both the ends.

In this sustemthe testing environment mainly consists of the following:

❖ **Software**

- Anaconda command line interface to run the server
- Visual Studio code for editing. Any code editing software can be used to write the programs
- Python ide to run python scripts
- SQL Database to store datasets of soil properties collected
- XAMPP server used to run the web server and the database server

❖ **Hardware**

- PC with sufficient storage space to store and run the module
- Internet connection

6.2 Test Case

Set of test inputs, execution conditions, and expected results were developed for a particular objective, such as to exercise a particular program path or to verify compliance with a specific requirement. It included the following:

❖ **Features to be tested**

- Sign up and sign in
- Crop prediction model
- Fertilizer prediction model

❖ **Items to be tested**

- Accuracy predictor scales
- Form inputs
- Submit button and other main menu buttons

❖ **Purpose of testing**

- To identify inaccurate predictions
- To make sure exception handling is done
- Incorrect inputs-in terms of values range or format of input-are identified

❖ **Pass/Fail criteria**

- If same inputs produce varying results, fail
- Inability to produce result when particular input is fed, fail
- Loading time to produce result exceeds threshold, fail
- Accurate result-as per analysis of database-for each type of crop taken into consideration, pass

6.3 Testing in Machine Learning

Machines learning is a study of applying algorithms and statistics to make the computer to learn by itself without being programmed explicitly. Computers rely on an algorithm that uses a mathematical model. The usage of the word "testing " in relation to Machine Learning models is primarily used for testing the model performance in terms of accuracy/precision of the model. It can be noted that the word, "testing" means different for conventional software development and Machine Learning models development.

Hence as mentioned above the traditional unit/integration testing would not work on machine learning models hence it is tested based on its accuracy and prediction.

Accuracy is unique metric for assessing cataloguing replicas. Informally, correctness is the part of predictions our archetypal got right. Formally, accuracy has the following definition:

Accuracy = Number of correct predictions/Total number of predictions

For binary classification, accuracy can also be calculated in terms of positives and negatives as follows:

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}$$

Where TP = True Positives, TN = True Negatives, FP = False Positives, and FN = False Negatives.
Precision and Recall is also used as a metric for evaluating classification models. Precision (also called positive predictive value) is the fraction of relevant instances among the retrieved instances, while recall (also known as sensitivity) is the fraction of the total amount of relevant instances that were actually retrieved.

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

When it comes to forecasting, the models are evaluated based on the expected results they predict. In the case of crop selection forecasting, we have divided the data into training set and testing set. Again, it is split into training dataset and validation dataset in the training set. We train our model using the training dataset and validation dataset is used to test the trained data. A validation dataset is a sample of data held back from training your model that is used to give an estimate of model skill while tuning model's hyperparameters.

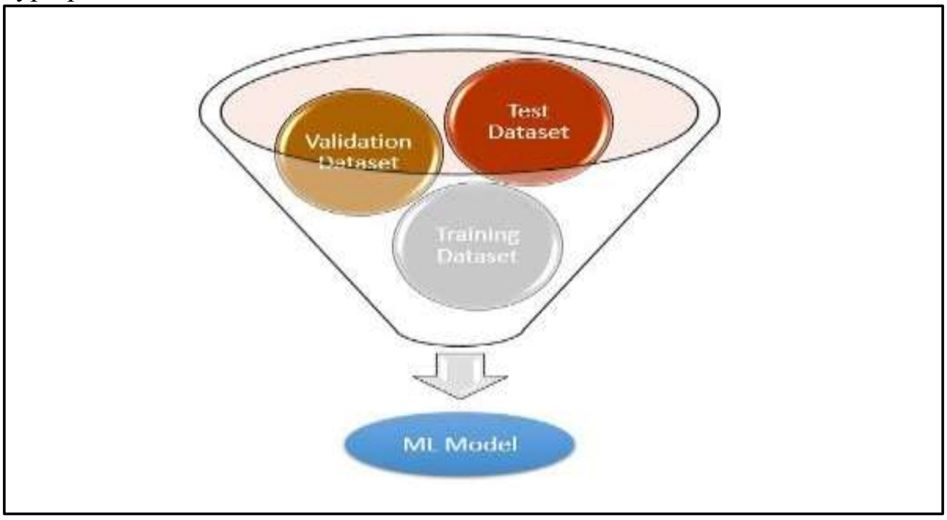


Figure 11. Filtration of Datasets

A test dataset is a dataset that is independent of the training dataset, but that follows the same probability distribution as the training dataset. If a model fit to the training dataset also fits the test dataset well. Hence by observing the predicted vs observed value we can tell how well our model works.

6.4 System Testing

System testing is the testing conducted on a complete, integrated system to evaluate the system compliance with its specified requirements. System testing involves putting the new program in many different environments to ensure that the program works in typical customer environments with various versions and types of operating systems and/or applications.

System testing is actually a series of different tests whose primary purpose is to fully exercise the computer-based system. Although each test has a different purpose, the main purpose is to verify that all the system elements have been properly integrated and perform the allocated functions.

6.5 Unit Texting

Unit testing is the mechanism where individual model of the projected is tested. It can also be called as differentiation testing, as the paper is tested based on individual model. Using the modules level designs depiction as a monitor significant device route is tested to discover faults around the boundary of each module.

7. RESULTS & DISCUSSION

The final application allows each user to create a dedicated account using an email and password. Once the user is logged in, they can perform the 2 functionalities of predicting a crop for a given soil type and the fertilizers required for the crop. This is achieved by providing inputs to the UI regarding various attributes of the soil. The accuracy with which the predictions are made is also displayed to the user. The Resultant Screenshots of the prototype are as shown below:

❖ **Login Page**

Figure 12: Login page with Sign in and Sign Up

❖ **Sign in Form**

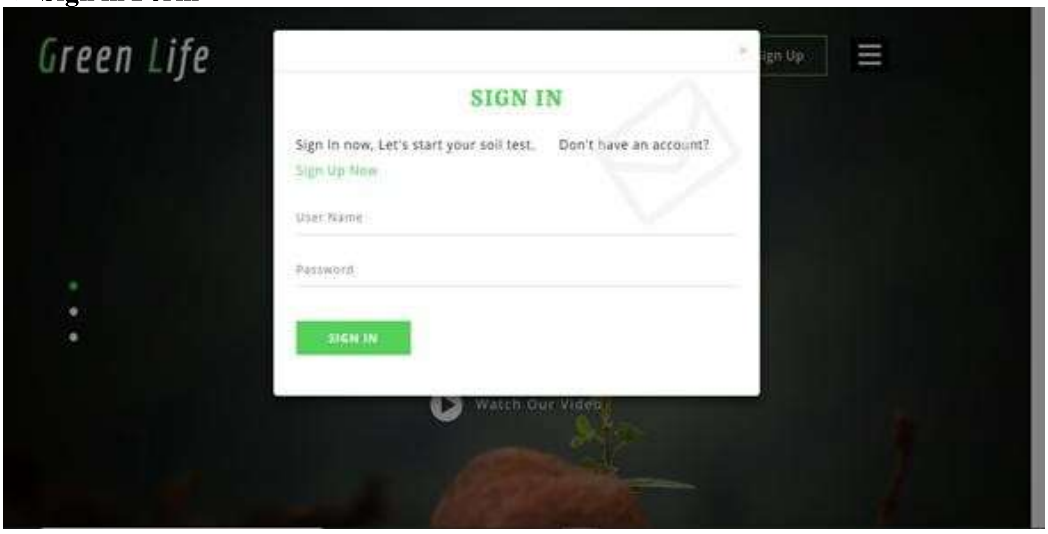


Figure 13: Sign in form for existing users

❖ **Sign up Form**

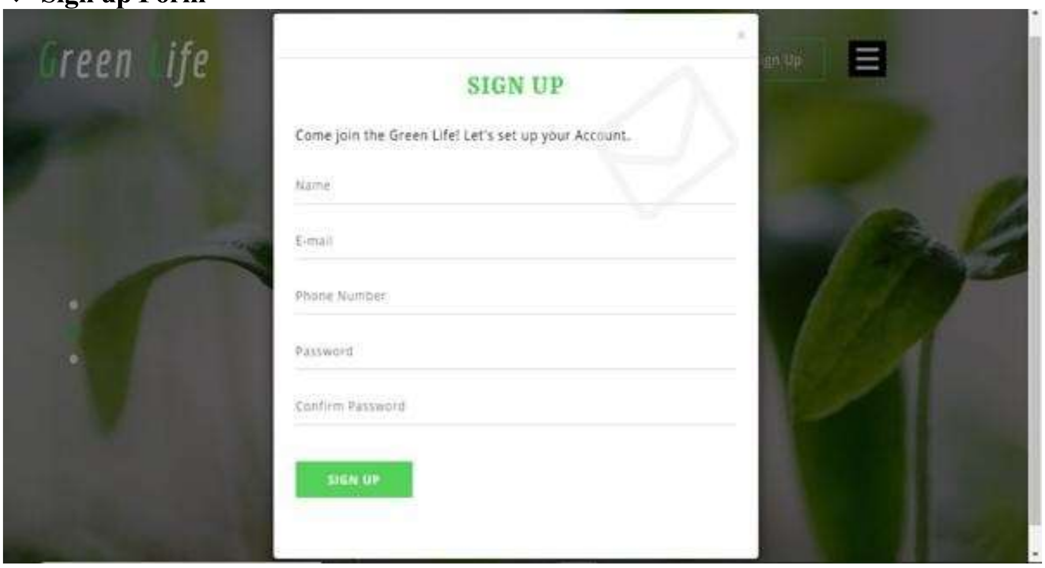


Figure 14: Sign up form for new users

❖ **Home Page**

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 10 No. 6s, 2024
https://theaspd.com/index.php

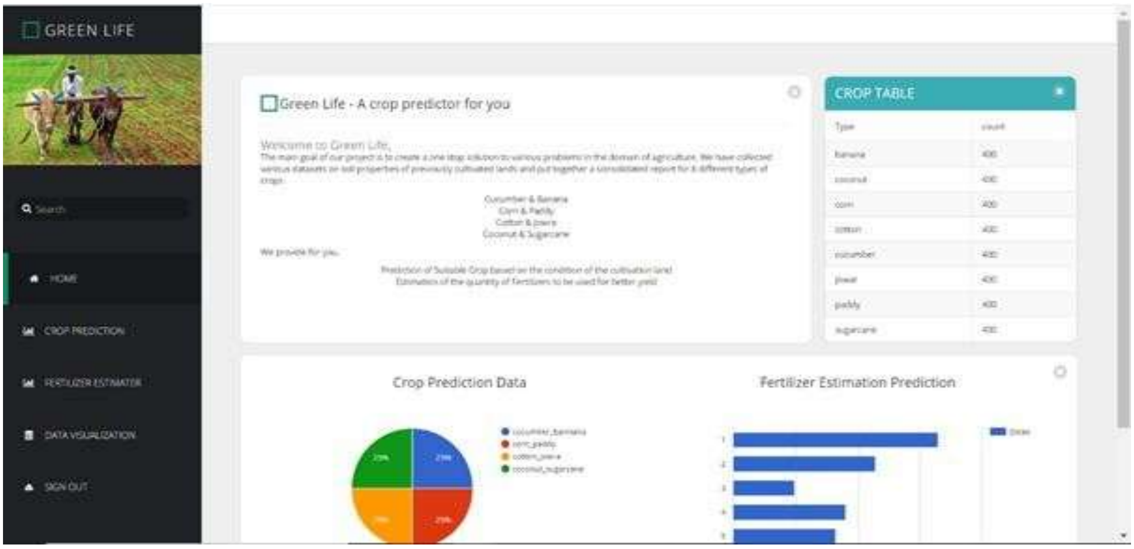


Figure 15: Home page with statistics of the datasets

- **Crop Prediction**

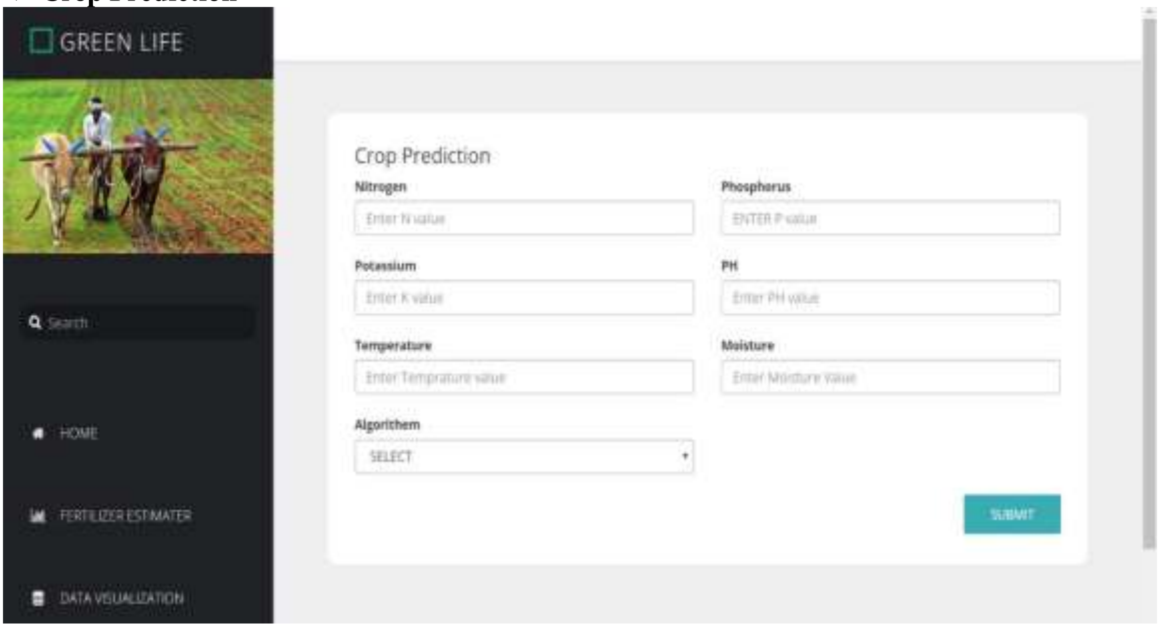


Figure 16: Inputting attributes for crop predictio

- **Result Page**

Figure 17: Output for the crop prediction on inputting the attribute values

- **Fertilizer Estimator**

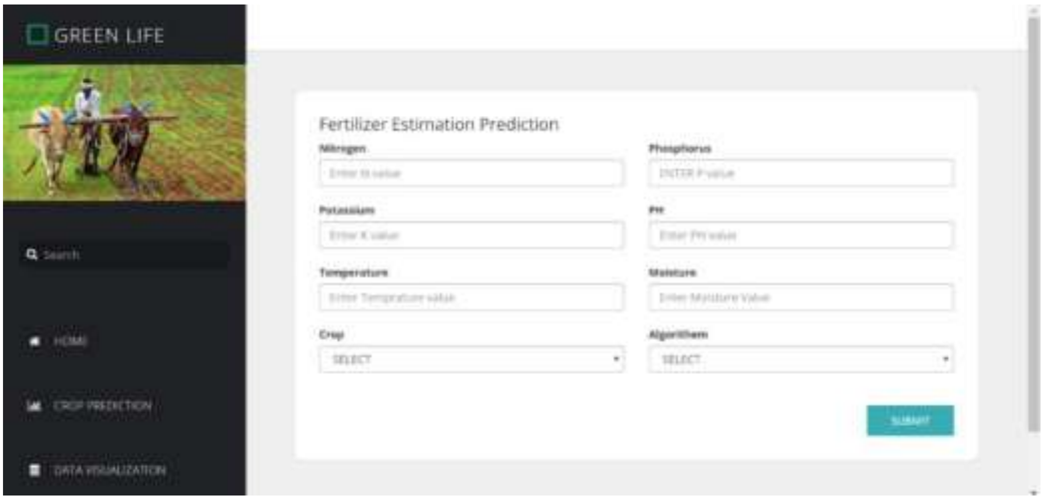


Figure 18: Inputting attribute values for fertilizer estimation

❖ **Data Visualization**

Figure 19: Data Visualization on accuracy of various algorithms

8. CONCLUSION AND SCOPE FOR FUTURE WORK

The structure "Agriculture(AIA) to Predictive Analysis for Crop Suitability and Fertilizer Efficiency" is established and verified positively and mollifies all the prerequisite of the User. The objectives that have been attained by the industrialized system are:

- Beginner's and condensed the physical work.
- Big capacities of data can be stored.
- It delivers Plane workflow.

It is successfully accomplished by applying KNN, SVM and Random Forest classification algorithm techniques. This classification techniques comes under data mining technology. This algorithm takes Temperature, electrical conductivity, moisture, Ph and NPK values as input and predicts the crop based on particular soil and land /area using IoT device and which is compared with master data.

Scope for Future Enhancement

- We can add IoT Sensor device to get values directly from soil testing sample/area of land to server, we can add device called sensors like PH, NPK and soil other sensors etc. As a part of parameter based on parameters crop can predicted which crop can be grown by farmer that can be suggested by admin and he can guide manually to farmer also.
- We can add Email module if any queries are there, the admin can directly interact with the administrator very easily.

  Email Module: In the proposed system, get the live data along with crop predicted values using IoT devices and sensors and is intimated manually, so we can add Email module as a future enhancement where Admin and Farmer can receive an Email notification regarding the Id and password.

- Audio output can be added that convert the result produced in text to speech in various dialects for better understanding by users.

REFERENCES

[1]. Sk Al Zaminur Rahman, Kaushik Chandra Mitra, S.M. Mohidul Islam. (2018). “Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series”. International Conference of Computer and Information Technology (ICCIT)
[2]. Zeel Doshi, Subhash Nadkarni, Rashi Agrawal, Prof. Neepa Shah (2018). “AgroConsultant: Intelligent Crop Recommendation System Using Machine Learning Algorithms”. Fourth International Conference on Computing Communication Control and Automation (ICCUBEA).
[3]. Arpit Rawankar, Mayurkumar Nanda, Hemant Jadhav, Prem Lotekar, Rahul Pawar, Libin Sibichan, Akshay Pangare. (2018) “Detection of N,P,K Fertilizers in Agricultural Soil with NIR Laser Absorption Technique”. 3rd International Conference on Microwave and Photonics (ICMAP 2018), 9-11 February, 2018
[4]. R. Ajith kumar, M.K. Muhammed Aslam, Jagathy Raj V.P, T. Radhakrishnan, K. Satheesh kumar, T. K.Manojkumar. “A Statistical Analysis of Soil Fertility of Thrissur District, Kerala”. 2016 IEEE. Indian Institute of Information Technology and Management –Kerala
[5]. Rakesh Kumar, M.P. Singh, Prabhat Kumar and J.P. Singh. “Crop Selection Method to Maximize Crop Yield Rate using Machine Learning Technique”. Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, T.N., India. 6 – 8 May 2015. pp.138-145.
[6]. Nidhi H Kulkarni, Dr. G N Srinivasan, Dr. B M Sagar, Dr.N K Cauvery. “Improving Crop Productivity Through A Crop Recommendation System Using Ensembling Technique”. 3rd IEEE International Conference on Computational Systems and Information Technology for Sustainable Solutions 2018
[7]. Anastasia Sofou, Student Member, IEEE, Georgios Evangelopoulos, Student Member, IEEE, and Petros Maragos. “Soil Image Segmentation and Texture Analysis: A Computer Vision Approach”. IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 2, NO. 4, OCTOBER 2005,https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS
[8]. S. Panchamurthi. M. E, M. D. Perarulalan, A. Syed Hameeduddin, P. Yuvaraj, "Soil Analysis and Prediction of Suitable Crop for Agriculture using Machine Learning", International Journal for Research in Applied Science & Engineering Technology (IJRASET)
[9]. Zeel Doshi, Subhash Nadkarni, Rashi Agrawal, Neepa Shah, "AgroConsultant: Intelligent Crop Recommendation System Using Machine Learning Algorithms"
[10]. Mr.Ambarish G. Mohapatra, Dr. Bright Keswani, Dr.Saroj Kumar Lenka, ". Jay Gholap, "PERFORMANCE TUNING OF J48 ALGORITHM FOR PREDICTION OF SOIL FERTILITY"
[11]. Keerthan Kumar T G, Shubha C, Sushma S A, “Random Forest Algorithm for Soil Fertility Prediction and Grading Using Machine Learning”
[12]. R. Jayalakshmi, M. Savitha Devi “Relevance of Machine Learning Algorithms on Soil Fertility Prediction Using R” https://towardsdatascience.com/support-vector-machine-introduction-to-machine-learning-algorithms-934a444fca47
[13]. Rakesh Kumar, M.P.Singh, Prabhat Kumar, J.P.Singh “Crop Selection Method to Maximize Crop Yield Rate using Machine Learning Technique” https://towardsdatascience.com/how-to-measure-distances-in-machine-learning-13a396aa34ce
[14]. Zhang L, Zhang J, Kyei-Boahen S, Zhang M,”Simulation and prediction of soybean growth and development under field conditions”. Am-Euras J Agr Environ Sci 7(4): 374-385, 2010
[15]. Nidhi H Kulkarni, Dr. G N Srinivasan, Dr. B M Sagar, Dr.N K Cauvery, "Improving Crop Productivity Through A Crop Recommendation System Using Ensembling Technique",3rd IEEE International Conference on Computational Systems and Information Technology for Sustainable Solutions 2018.
[16]. Keerthan Kumar T G, Shubha C, Sushma S A, "Random Forest Algorithm for Soil Fertility Prediction and Grading Using Machine Learning",International Journal of Innovative Technology and Exploring Engineering (IJITEE).
[17]. Gorthi, Swathi and Huifang Dou. “PREDICTION MODELS FOR ESTIMATION OF SOIL MOISTURE CONTENT.” (2011). https://towardsdatascience.com/ensemble-methods-in-machine-learning-what-are-they-and-why-use-them-68ec3f9fef5f
[18]. Nidhi H Kulkarni, Dr. G N Srinivasan, Dr. B M Sagar, Dr. N K Cauvery “ Improving Crop Productivity Through A Crop Recommendation System Using Ensembling Technique”