A
Project Stage-I Presentation
on

IoT-enabled Cropping Pattern based on Weather Conditions and Soil Compositions using Machine Learning and Deep Learning Techniques

in
Partial Fulfillment of Final Year Computer Engineering Course - Project Stage - I
by

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Contents

Problem Statement

IoT-enabled Cropping Pattern based on Weather Conditions and Soil Compositions using Machine Learning & Deep Learning Techniques

Short Introduction

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

Motivation

- **Inaccurate selection of crops due to lack of knowledge in weather, soil and crop cultivation.**
- **Unhealthy and hindered growth of crops due to selection of inappropriate time for sowing seeds.**
- **This can cause a decrease in the country's GDP.**
- **Agriculture plays a vital role in Indian economy it contributes 18% of total India's GDP.**
- **Due to sudden changes in climatic conditions the crop planted by farmers get damaged.**
- **Many time due to overuse of fertilizers and pesticides the crop gets damaged.**

Objectives

- **To survey and analyze** existing problems on agriculture research related to crop selection using Deep Learning Techniques.
- **To identify and analyze** different soil and weather parameters.
- **To collect and preprocess** soil health dataset for crop selection and appropriate cultivation time.
- **To develop** an efficient model for crop selection and for suggesting appropriate time for cultivation using IoT and Deep Learning Techniques.

Scope & Feasibility

- **Suggestion of suitable crops based on weather and soil parameters only for particular provinces like Maharashtra.**
- **Application for Android users only.**
- **The application will be useful for farmers only.**

Project Requirements

- **S/W Requirements -**

  Android Studio (Software Building), Jupyter Notebook (Machine Learning Model Building) and software for building IoT model.

- **H/W Requirements -**

  Sensors for testing soil parameters, Arduino board, and a PC for development.

- **Functional Requirements -**

  Getting current weather data using weather API, getting soil composition data using IoT devices, suggesting user with appropriate crop based above two factors, etc

- **Non Functional Requirements -**

  Scalability, Capacity, Availability, Reliability, Recoverability, Maintainability.

Literature Survey

Reference 1	Sonal Jain, Dharavath Ramesh, “Machine Learning convergence for weather based crop selection”, IEEE International Students’ Conference on Electrical, Electronics and Computer Science, 2020.
Objectives	Training a Weather forecasting model and by using soil parameters for better selection of crop and suggesting accurate season for crop cultivation.
Proposed Solution	This paper proposes weather forecasting model using RNN. This model also uses LSTM for prediction. The prediction is done for maximum temperature, minimum temperature and rainfall.
Results	The proposed model using RNN is able to predict time-series data more accurately with an Acceptable error. The performance of RNN model is compared with ANN model and the results are that the RNN model performs much better than ANN model.
Advantages	RNN algorithm gives more efficiency then ANN model. Time-series data can be predicted more accurately using RNN.
Limitations	Gradient vanishing and exploding problems while using RNN algorithm.

Reference 2	Sneha Gumaste, Prof. Anilkumar Kadam, “Future Weather Prediction Using Genetic Algorithm and FFT for Smart Farming”, IEEE International Students’ Conference on Electrical, Electronics and Computer Science.
Objectives	Planning the pre-post activities for farming by future weather prediction using user’s location.
Proposed Solution	Present weather conditions are taken from user’s location using GPS and predicting future weather conditions using genetic algorithm and FFT for planning pre-post activities for farming. Weather and crop damage alerts are also sent to users via sms or email to farmers.
Results	Farmers will be able to get future weather forecast and would greatly help to improve overall productivity of agriculture.
Advantages	Using Genetic and FFT algorithm future values of weather data is predicted with precision.
Limitations	Soil compositions are not taken into consideration which impacts most of the plants, only weather parameters with few parameters are considered.

Reference 3	Lia Kamelia; Yuga Setya Nugraha; Mufid Ridlo Effendi; Tedi Priatna “The IoT-Based Monitoring Systems for Humidity and Soil Acidity Using Wireless Communication” 2019 IEEE 5th International Conference on Wireless and Telematics (ICWT) 25-26 July 2019.
Objectives	Provide info soil pH and humidity values so that farmers can make sure their crops grow well
Proposed Solution	Use of sensors to get pH and humidity values from soil and then transmitting that data to a controller like a Arduino.
Advantages	Easy to implement and use. Low cost and also small in size.

Reference 4	Sk Al Zaminur Rahman, ”Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series ”,” 21st International Conference of Computer and Information Technology (ICCIT), 21-23 December, 2018”
Objectives	Predict soil series with land type and according to prediction it can suggest suitable crops.
Proposed Solution	Classification of soil by using Support Vector Machines (SVM) algorithm
Results	The prediction accuracy of the model accounts to 94.95%.
Advantages	1. Accuracy 2. Works very well with limited datasets
Limitations	1.Does not work well with larger datasets 2.Sometimes, training time with SVMs can be high

Reference 5	R. Kumar, M. Singh, P. Kumar, and J. Singh, “Crop selection method to maximize crop yield rate using machine learning technique,” in 2015 international conference on smart technologies and management for computing, communication, controls, energy and materials (ICSTM). IEEE, 2015, pp. 138–145.
Objectives	To solve crop selection problem, and maximize net yield rate of crop over season and subsequently achieves maximum economic growth of the country.
Proposed Solution	This paper proposed a method named Crop Selection Method (CSM) to achieve net yield rate of crops over season . Classified crops in 4 types Seasonal crops, Whole year crops, Short time and long time plantation crops.
Results	CSM method may improve net yield rate of crops to be planted over season. The proposed method resolves selection of crop (s) based on prediction yield rate influenced by parameters (e.g. weather, soil type, water density, crop type) with accuracy upto 83%.
Advantages	Finds a sequence of crops whose production per day are maximum over season.
Limitations	Performance and accuracy of CSM method depends on predicted value of influenced parameters, so there is a need to adopt a prediction method with more accuracy and high performance

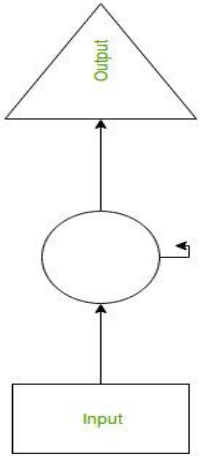
Algorithmic Survey

Recurrent Neural Networks - Weather Forecasting

- **Input -** Current weather conditions are fetched from Open Weather API according to user's location and fed to the weather forecasting model.
- **Data Preprocessing -** All the missing data and noisy data are processed using proper techniques and data is normalized and discretized.
- **Model -** As compared with other model used for weather forecasting, Recurrent Neural Networks give higher efficiency. So, for weather forecasting Recurrent Neural Networks is chosen.
- **Output -** The weather forecast will be given in terms of weather parameters as a matrix whose rows will define each weather parameter and each column will define the weather condition predicted for that day.

Working of RNN

- RNN converts the independent activations into dependent activations by providing the same weights and biases to all the layers, thus reducing the complexity of increasing parameters and memorizing each previous outputs by giving each output as input to the next hidden layer.
- Hence these hidden layers can be joined together such that the weights and bias of all the hidden layers is the same, into a single recurrent layer.



- **Formula for calculating current state:**

$$h_t = f(h_{t-1}, x_t)$$

Where:

h_t -- current state

h_{t-1} -- previous state

x_t -- input state

- **Formula for applying Activation Function(tanh):**

$$h_t = \tanh(W_{hh}h_{t-1} + W_{xh}x_t)$$

Where:

W_{hh} -- weight at recurrent neuron

W_{xh} -- weight at input neuron

- **Formula for calculating output:**

$$y_t = W_{hy}h_t$$

Where:

y_t -- Output

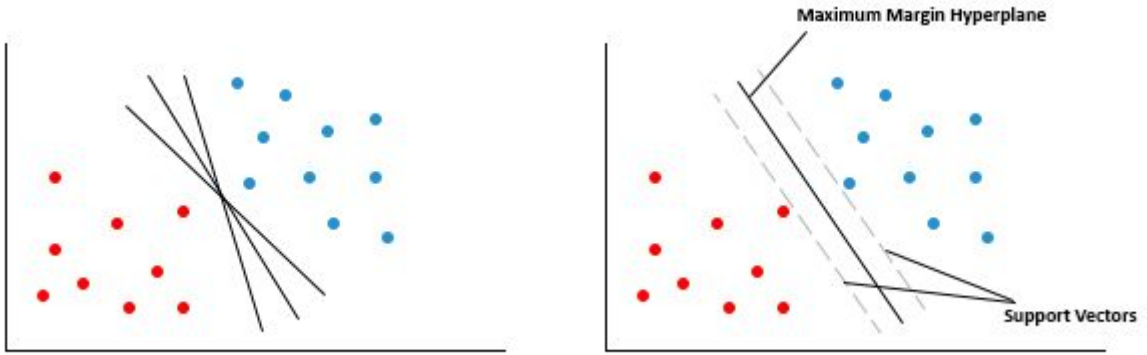
W_{hy} -- weight at output layer

Support Vector Machine - Soil Classification

- **Input -** Current soil composition is fetched from the IoT system and then fed to soil classification model.
- **Data Preprocessing -** All the missing data and noisy data are processed using proper techniques and data is normalized and discretized.
- **Model -** Support Vector Machine (SVM) algorithm is specially known for classification problems, and it is best fitted for soil classification with highest efficiency.
- **Output -** We will known the type of soil and also its compositions (like N, P, K, temperature, moisture, humidity, etc).

SVM - Mathematical Model

- SVM relies on making a line of separation that classifies the data into different groups.
- But there occurs situations where multiple lines satisfy the situation but each one of them lead a different efficiency apon training (left figure).
- SVM aims at finding the most optimal line amongst these set of possible lines that will provide the best results (right figure). This line is termed as Maximum Margin Hyperplane.



- SVM achieves this by finding the line with maximum margin.
- A powerful insight is that the linear SVM can be rephrased using the inner product of any two given observations, rather than the observations themselves. The inner product between two vectors is the sum of the multiplication of each pair of input values.
- For example, the inner product of the vectors [2, 3] and [5, 6] is 2*5 + 3*6 or 28.
- The equation for making a prediction for a new input using the dot product between the input (**x**) and each support vector (**xi**) is calculated as follows:

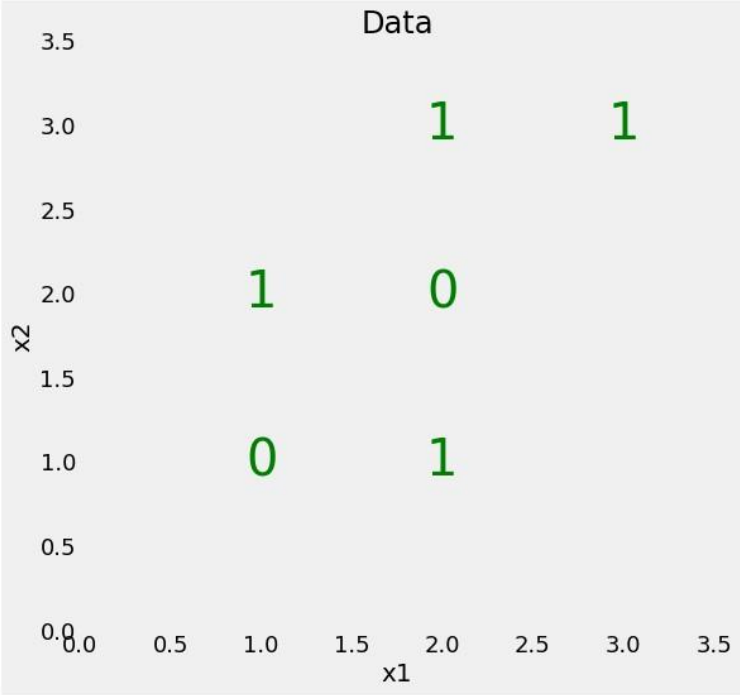
$$f(x) = B_0 + sum(ai * (x, xi))$$

- This is an equation that involves calculating the inner products of a new input vector (x) with all support vectors in training data. The coefficients B0 and ai (for each input) must be estimated from the training data by the learning algorithm.

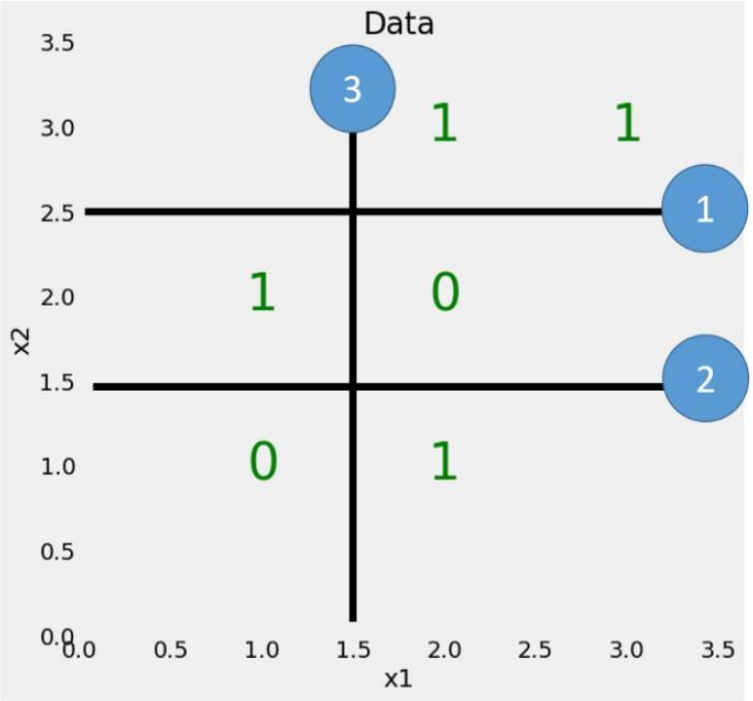
Random Forest Classifier - Crop Selection

- **Input -** The output from weather forecasting model and soil classification model is given as input to the crop selection model.
- **Data Preprocessing -** As the data fed to the model came from another model, so data preprocessing is not required.
- **Model -** Random Forest Classification algorithm is used for classification of appropriate crops. Random forest classification algorithm is capable of giving multiple outputs as compared with other classification algorithms.
- **Output -** The crop selection model will give a list of suitable crops to the user based on the upcoming weather conditions and soil composition.

Binary Classification Example



The goal is to divide the data points into their respective classes.



Splits made by the decision tree.

Gini Impurity

The Gini Impurity of a node is the probability that a randomly chosen sample in a node would be incorrectly labeled if it was labeled by the distribution of samples in the node. For example, in the top (root) node, there is a 44.4% chance of incorrectly classifying a data point chosen at random based on the sample labels in the node.

$$I_G(n) = 1 - \sum_{i=1}^{J} (p_i)^2$$

Gini impurity of a node n.

The Gini Impurity of a node n is 1 minus the sum over all the classes J (for a binary classification task this is 2) of the fraction of examples in each class p_i squared.

$$I_{root} = 1 - ((\frac{2}{6})^2 + (\frac{4}{6})^2) = 1 - \frac{5}{9} = 0.444$$

Gini Impurity of the root node

$$I_{\text{second layer}} = \frac{n_{\text{left}}}{n_{\text{parent}}} * I_{\text{left node}} + \frac{n_{\text{right}}}{n_{\text{parent}}} * I_{\text{right node}} = \frac{4}{6} * 0.5 + \frac{2}{6} * 0.0 = 0.333$$

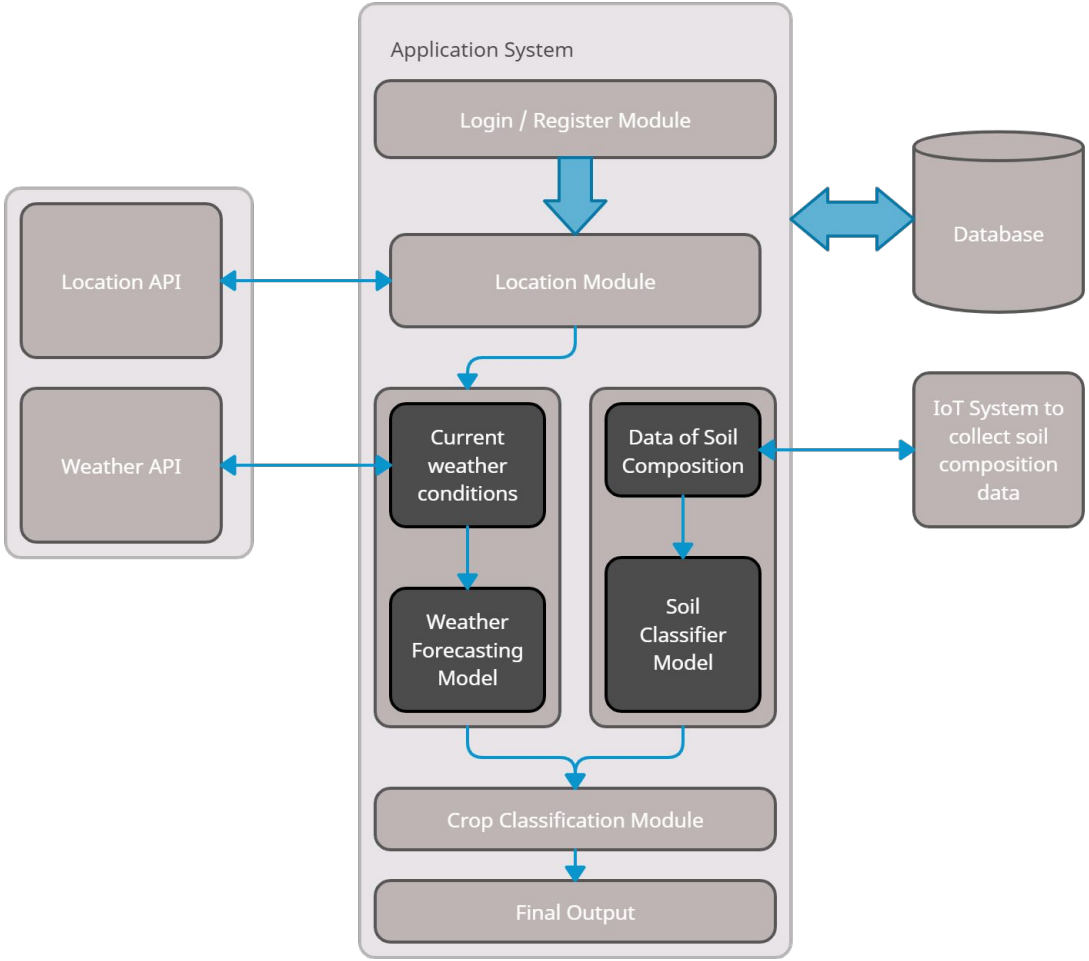
Eventually, the weighted total Gini Impurity of the last layer goes to 0 meaning each node is completely pure and there is no chance that a point randomly selected from that node would be misclassified.

Entropy

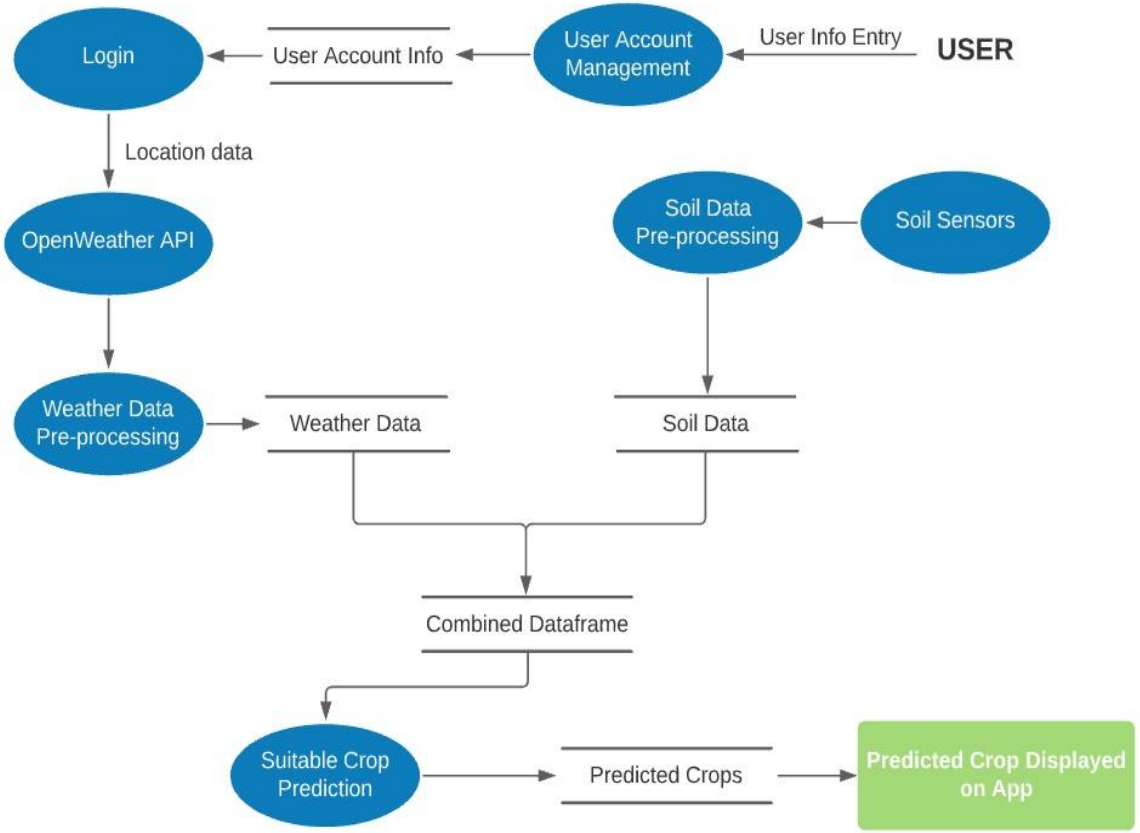
Entropy uses the probability of a certain outcome in order to make a decision on how the node should branch.

$$Entropy = \sum_{i=1}^{C} -p_i * \log_2(p_i)$$

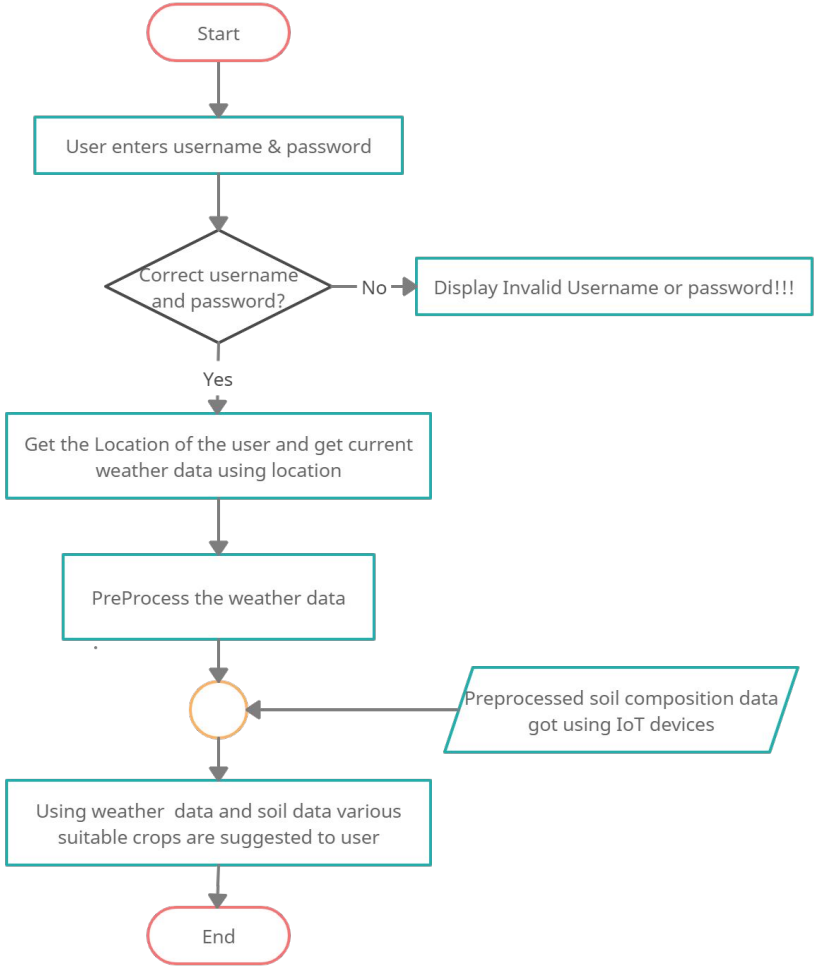
System Architecture Design



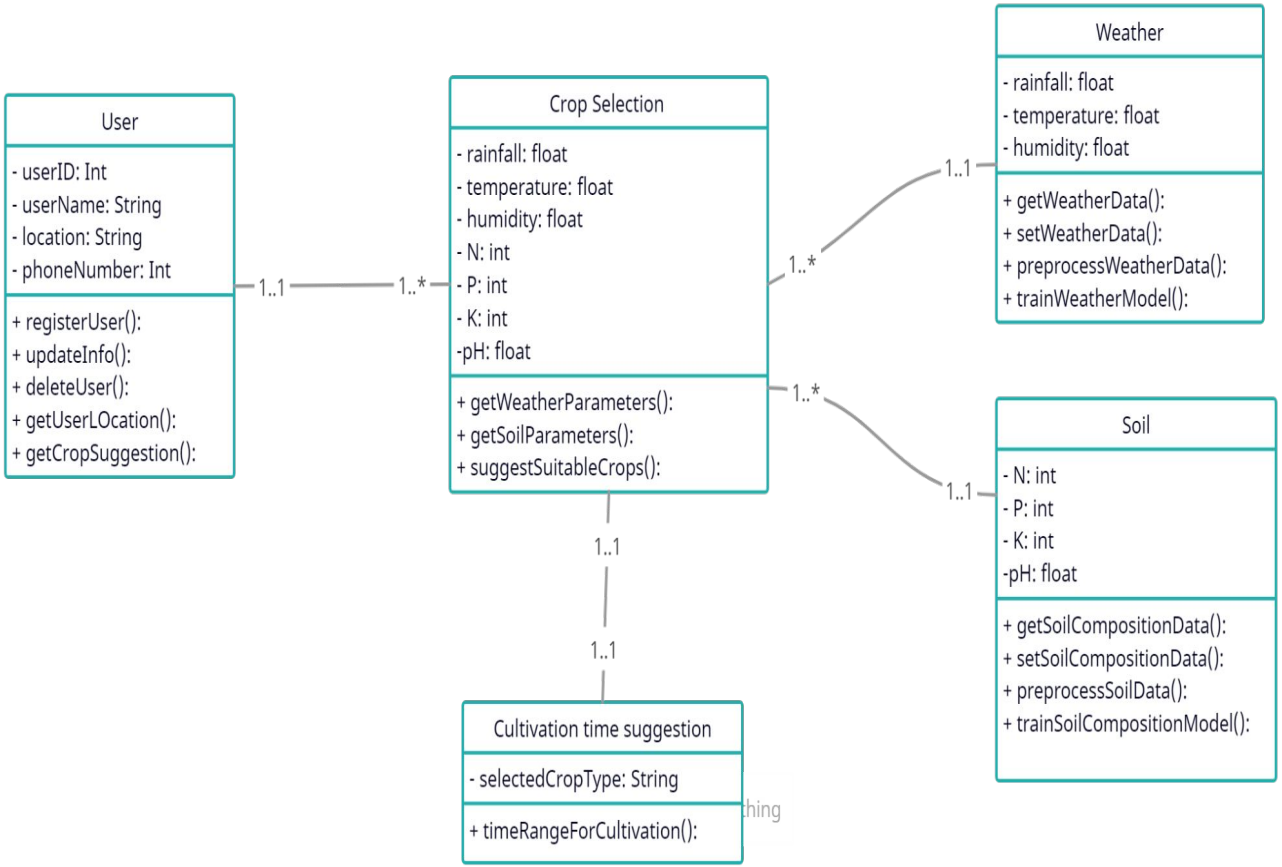
Data Flow Diagram



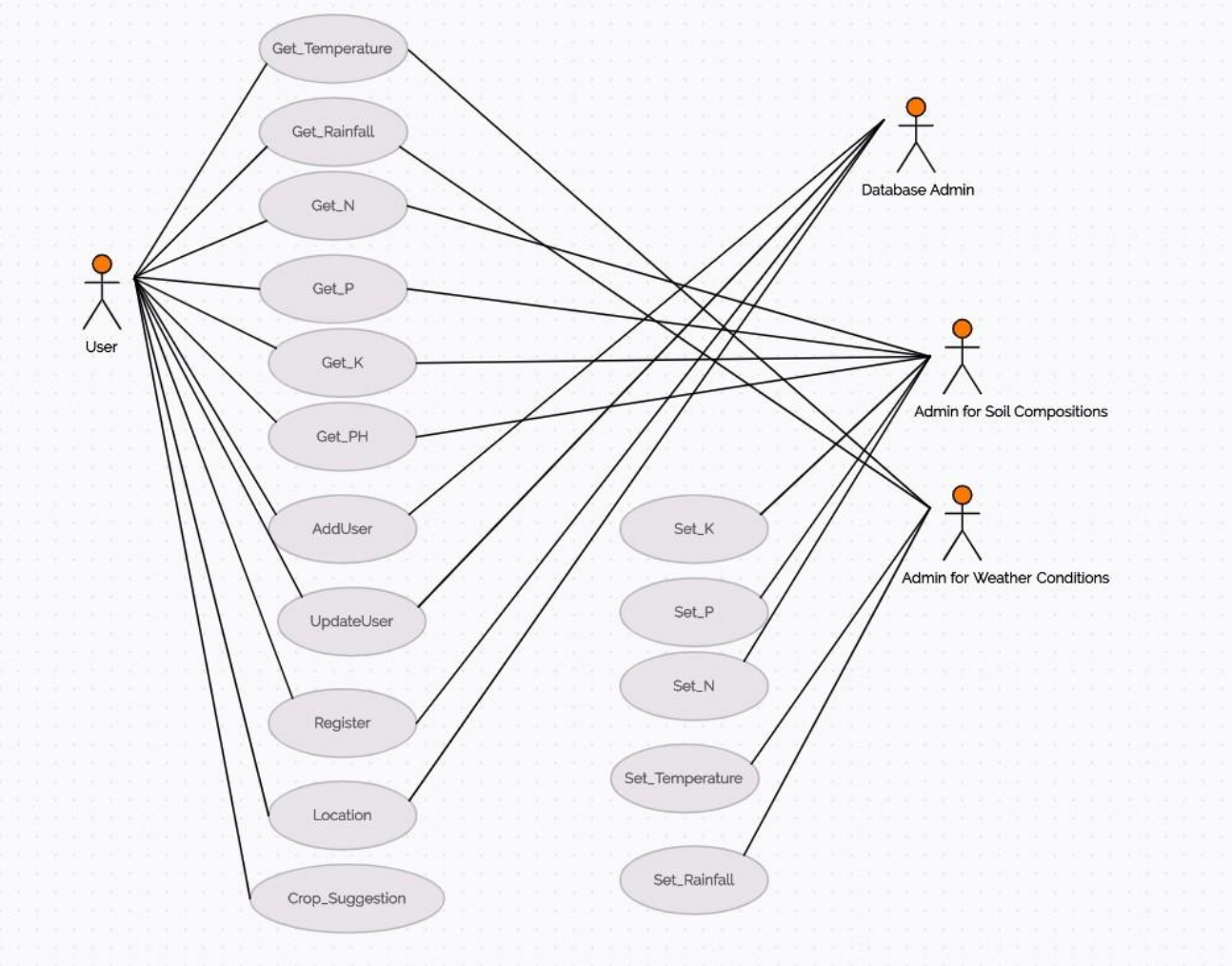
Activity Diagram



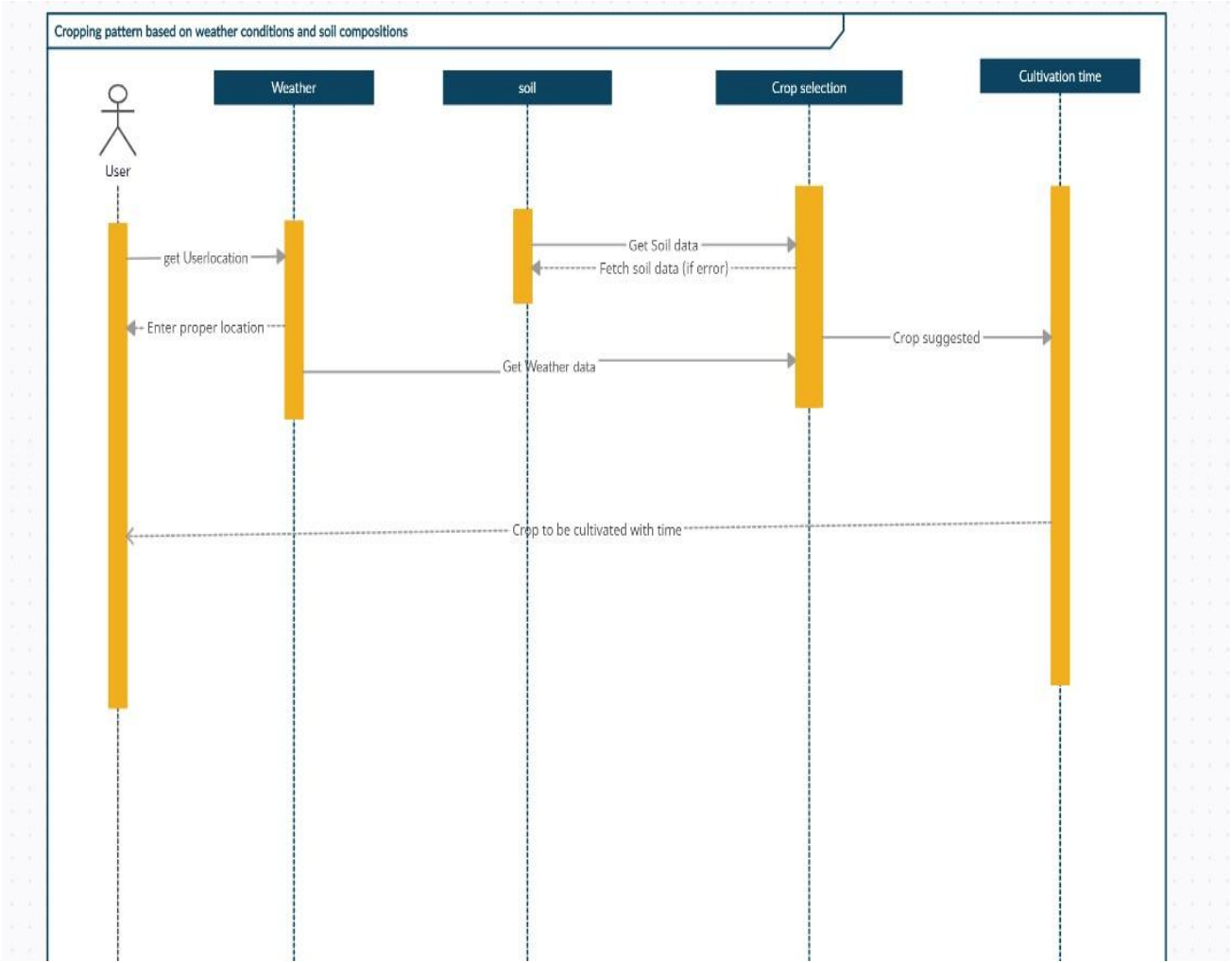
Class Diagram



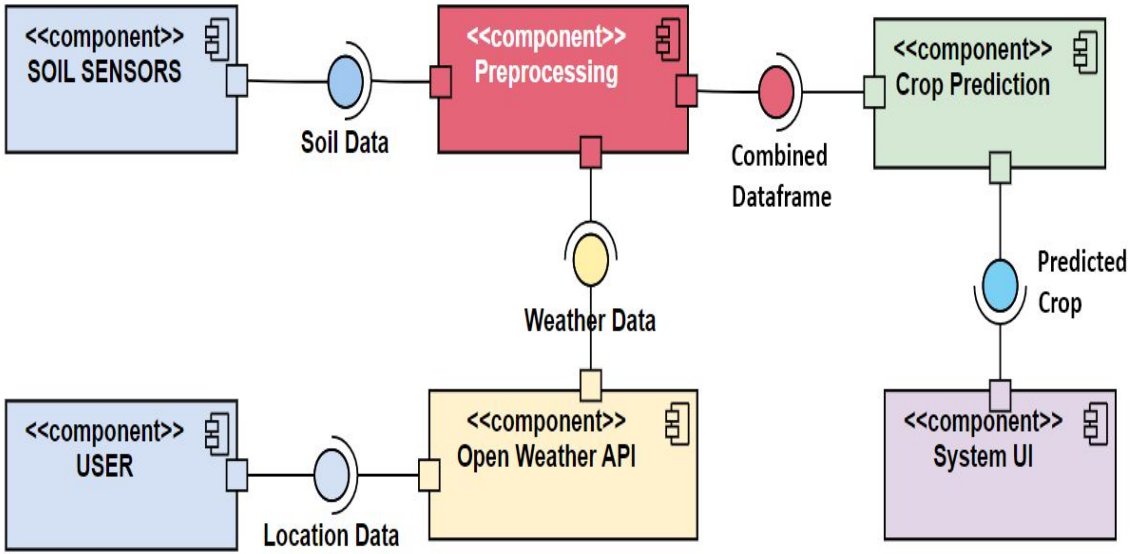
Use case Diagram



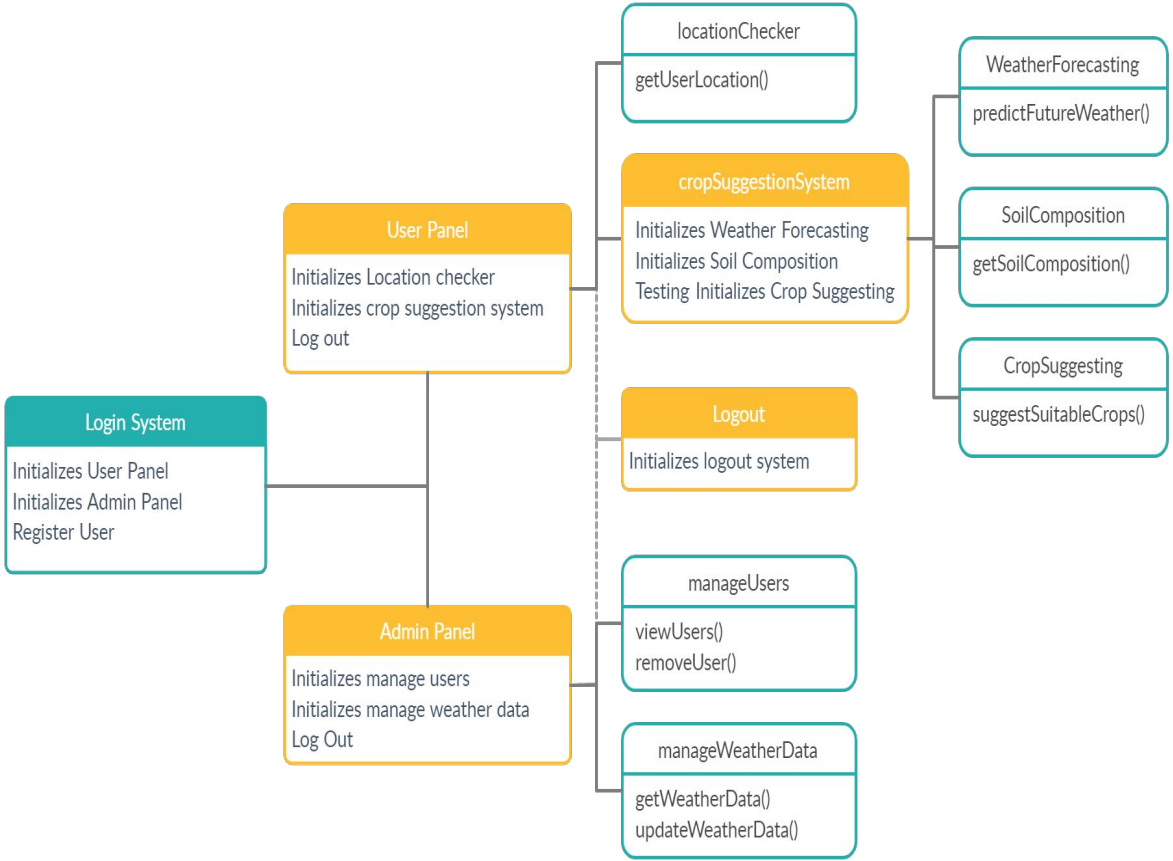
Sequence Diagram



Component Diagram



Deployment Diagram



Project Implementation Plan

Implementation Plan (Stages)	Time (Months)			
	June - July	August - September	October	November
i. Project Scoping	[redacted]			
ii. Analysis and Research	[redacted]	[redacted]		
iii. System Design		[redacted]	[redacted]	
iv. Prototype testing			[redacted]	[redacted]
v. Implementation				[redacted]
vi. Improvement				

Conclusion

- The algorithm developed introduces a data driven model to predict and forecast weather. The outcomes of this research can benefit the agriculturists/ farmers by knowing the investment capital on the crop to be sown, even before the sowing season begins. The predictive pattern of the algorithm can benefit local self-governments and financial institutions to allocate suitable funds or fiscal loans to farmers.
- The proposed method represents crop selection system to select suitable crops to cultivate on the agriculture land, based on predicted weather parameters and its soil parameters.
- Using sensors is a automated system for majority part which leaves very little space for errors in gathering essential data.

References

1. Sonal Jain, Dharavath Ramesh, “Machine Learning convergence for weather based crop selection”, IEEE International Students’ Conference on Electrical, Electronics and Computer Science, 2020.
2. Shruti Kulkarni, Shah Nawaz Mandal, G Shrivatsa Sharma, Monica Mundada, Meera Devi, “Predictive Analysis to Improve Crop Yield using a Neural Network Model”, IEEE International Students’ Conference on Electrical, Electronics and Computer Science, 2018.
3. Nitin Singh, Saurabh Chaturvedi, Shamin Akther, “Weather Forecasting Using Machine Learning Algorithm”,I EEE 2019 International Conference on Innovations in Science, Engineering and Technology (ICISET), 2019.
4. S. Karthick, D. Malathi, C. Arun, “Weather prediction analysis using random forest algorithm”, International Journal of Pure and Applied Mathematics Volume 118 No. 20 2018.
5. K. Geetha Rani, Dr. D. C. Joy Winnie Wise, S. Sufiyah Begum, S. Nirosha, “Designing a model for weather forecasting using machine learning”, Proceedings of the International Conference on Electronics and Sustainable Communication Systems, 2020.
6. Sneha Gumaste, Prof. Anilkumar Kadam, “Future Weather Prediction Using Genetic Algorithm and FFT for Smart Farming”, IEEE International Students’ Conference on Electrical, Electronics and Computer Science.
7. Udit Shandilya, Vidhi Khanduja, “Intelligent Farming System With Weather Forecast Support and Crop Prediction”, IEEE Xplore.
8. E. Sreehari, Dr.Satyajee Srivastava, “Prediction of Climate Variable using Multiple Linear Regression”, IEEE 2018.

9. Shivam Bang, Rajat Bishnoi, Ankit Singh Chauhan, Akshay Kumar Dixit, Indu Chawla, “Fuzzy Logic based Crop Yield Prediction using Temperature and Rainfall parameters predicted through ARMA, SARIMA, and ARMAX models”, IEEE 2019.
10. R. Kumar, M. Singh, P. Kumar, and J. Singh, “Crop selection method to maximize crop yield rate using machine learning technique,” in 2015 international conference on smart technologies and management for computing, communication, controls, energy and materials (ICSTM). IEEE, 2015, pp. 138–145
11. S. Pudumalar, E. Ramanujam, R. H. Rajashree, C. Kavya, T. Kiruthika, and J. Nisha, “Crop recommendation system for precision agriculture,” in 2016 Eighth International Conference on Advanced Computing (ICoAC). IEEE, 2017, pp. 32–36.
12. Basso B, Bodson B, V. Leemans, B. Bodson, J-P Destain, M-F Destain, “A comparison of within season yield predictions algorithm based on crop model behaviour analysis”, Agricultural and Forest Meteorology, Volume 204, pp. 10-21, May 2015.
13. Predictive Analysis to Improve Crop Yield using a Neural Network Model Shr uti Kulkarni Shah Nawaz Mandal G. Srivatsa Sharma Monica R. Mundada Meera devi
14. Thoranin Sujjaviriyasup, Komkrit Pitiruek, ”Agricultural Product Forecasting Using Machine Learning Approach”. Int. Journal of Math. Analysis, Vol. 7, no. 38, 1869 1875, 2013.
15. Wiwien Hadikurniawati, Edy Winarno, Dwi Budi Santoso, Purwatiningtyas, “A Mixed Method using AHP-TOPSIS for Dryland Agriculture Crops Selection Problem”, IEEE Xplore 2019.
16. Penpun Chaihuadjaroen, Pannawat Thanapirompokin, “Applied Genetic Algorithm per environment zone to solve problem of crops selection for intercropping by modified parameter of fitness function”, IEEE 2019
17. Sk Al Zaminur Rahman, ”Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series ”,” 21st International Conference of Computer and Information Technology (ICCIT), 21-23 December, 2018”
18. Uday Kiran,”SOIL CLASSIFICATION AND CROP SUGGESTION USING MACHINE LEARNING”,”International Research Journal of Engineering and Technology (IRJET),2020”.

19. Ritula Thakur, “Recent Trends Of Machine Learning In Soil Classification”, International Journal of Computational Engineering Research (IJCER),2018.
20. Mrs. N. Saranya,”Classification of Soil and Crop Suggestion using Machine Learning Techniques ”,International Journal of Engineering Research & Technology (IJERT), Feb-2020.
21. Archana Reddy, “Soil Classification and Crop Suggestion using Machine Learning”, “International Journal for Research in Applied Science & Engineering Technology (IJRASET)”,July-2020.
22. T. Abimala, S. Flora Sashya and K. Sripriya, “Soil Classification and Crop Suggestion using Image Processing”, EasyChair preprints, June 3, 2020.
23. Priyanka Dewangan, Vaibhav Dedhe, “Soil Classification Using Image Processing and Modified SVM Classifier”, International Journal of Trend in Scientific Research and Development (IJTSRD), 2018.
24. Lia Kamelia; Yuga Setya Nugraha; Mufid Ridlo Effendi; Tedi Priatna “The IoT-Based Monitoring Systems for Humidity and Soil Acidity Using Wireless Communication” 2019 IEEE 5th International Conference on Wireless and Telematics (ICWT) 25-26 July 2019.
25. Muhammad F. Farooqui; Ahmed A. Kishk “Low-Cost 3D-Printed Wireless Soil Moisture Sensor” 2018 IEEE SENSORS 28-31 Oct. 2018.
26. Newton S. S. M. da Fonseca; Raimundo C. S. Freire; Adriano Batista; Glauco Fontgalland; Smail Tedjini “A passive capacitive soil moisture and environment temperature UHF RFID based sensor for low cost agricultural applications” 2017 SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference (IMOC) 27-30 Aug. 2017
27. Sachin Kumar, Baban Kumar, Ritula Thakur, Manish kumar “Soil pH Sensing Techniques and Technologies A Review” May 2015.
28. Poltak Sihombing, Bisman Peranginangin, Dahlan Sitompul, and Rido Rivaldo “Tools For Detecting and Control of Soil pH by Probe Sensor based on Android”.
29. Mukul Singh, Rajul Patkar, Madhuri Vinchurkar and Maryam Shojaei Baghini, “Cost Effective Soil pH Sensor using Carbon based Screen-Printed Electrodes”, IEEE Sensors Journal.
30. Matti Satish Kumar, T Ritesh Chandra, D Pradeep Kumar and Dr. M. Sabarimalai Manikandan, “Monitoring moisture of soil using low cost homemade Soil Moisture Sensor and Arduino UNO”, (ICACCS -2016)

Paper Submission Details

FTNCT-2021 Submission 122

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The submission has been saved!

Submission 122	
Title:	Cropping Pattern based on Weather Conditions and Soil Composition - A Survey
Paper:	(Oct 29, 09:24 GMT)
Author keywords:	Machine Learning IoT Agriculture
Abstract:	Generally, cropping patterns are mostly based on weather conditions and also on the composition of the soil. So selecting the crop based on the upcoming climating conditions and suitable for the type of land chosen, we can yield better than other crops and increase our profits. In recent years, researchers have run missions such as weather forecasting and soil composition testing. By taking into account the available data, our study evaluates a wide range of weather figure methods, soil composition methods, and methods for determining the best cropping pattern. Due to changing weather conditions and soil compositions, determining exact cropping patterns has become a difficult issue. This survey examines various machine learning, deep learning, and neural network methodologies for this project.
Submitted:	Oct 29, 09:24 GMT
Last update:	Oct 29, 09:24 GMT

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ICEI-2022 Submission 42

Update information
Update authors
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The submission has been saved!

Submission 42	
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Topics:	Artificial Intelligence and Machine Learning, Embedded Systems and Internet of Things
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Thank You !