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## AI – Based Smart Irrigation System

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**Abstract:** Globally, irrigation is scheduled according to crop visual inspection by farmers and as a result, about 50% of water is wasted by traditional irrigation systems. Sprinkle irrigation, drip irrigation, and furrow irrigation are examples of controlled irrigation methods that decrease water wastage by 30 – 70%. These systems, however, fail to hold precise water in the soil owing to their open structure, which affects the quality and number of plants by irrigating less or dramatically reducing soil nutritive. Therefore, there's a desire for feedback on integrated precision irrigation practices to efficiently utilize water without harming the development of crops. Precision irrigation takes soil moisture, climate information, and crop type to estimate water is required or not. It therefore reduces the cost of farm workers. The proposed system uses a hybrid random forest with a linear model (HRFLM) for prediction work. For the hybrid random forest and linear models, we employed an ensemble voting classifier. Due to the architecture of the hybrid algorithm, we achieved accuracy for prediction. To get more than 96% of accuracy.

**Keywords:** Hybrid random forest with a linear model, Random Forest, Precision irrigation, Remote Sensing, Voting classifier.

### I Introduction

Precision Agriculture (PA) is the science of employing high – tech sensor and analytic technologies to increase agricultural fields and help management choices. [1] PA is a new concept universally accepted to increase productivity, reduce labor time, and ensure effective management of fertilizers and irrigation processes. It uses a large amount of

data and information to improve using agricultural resources, yields, and the quality of crops.

PA is an innovative, streamlined, state – of – the – art field management strategy used in agriculture to improve resources efficiency in the agricultural sector [7]. Therefore, PA is a new best practice for farmers to provide optimized inputs such as water and fertilizer to improve productivity, quality, and yield. It necessitates a large volume of crop health data at high spatial resolution during the growing season. Regardless of the data source, the most important goal of PA is to assist farmers in managing their businesses. Support can take many forms, but the final effect is usually a reduction in the amount of resources required.

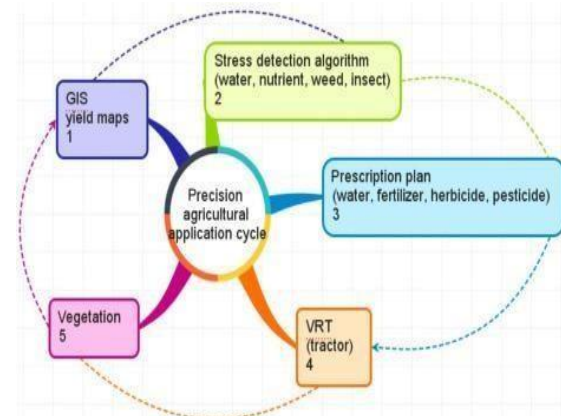


Fig 1. Precision Agricultural Application Cycle

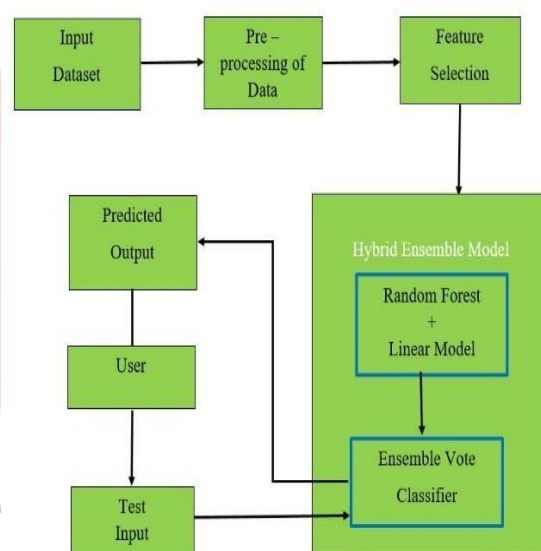
As fig 1 shows the precision agricultural cycle. Modern agricultural production relies on monitoring the popularity of crops by observing and measuring variables such as soil moisture, plant health, fertilizer, and pesticide exposure, irrigation and crop yield. Managing all these factors is a major challenge for crop producers. Accurate monitoring of agricultural growth and rapid advances in clinical evaluation are essential for efficient use of agricultural resources and crop management. [2] These challenges can be addressed by introducing remote sensing (RS) systems, such as hyperspectral imaging, to obtain accurate maps of biophysical indicators at various crop development cycles.

RS is a rapidly evolving technology used in a variety of agricultural applications. In particular, continuous narrow – band imaging spectroscopy provides important information for understanding the biophysical and biochemical properties of crops [3]. It is also beneficial to identify the changes in various physical processes, which can be better identified using multispectral RS. [4] The improved RS method was used for large crop inventory and yield forecasting. Remote sensing applications are used in agricultural research based on the interaction of electromagnetic radiation with soil or plant materials on the Earth's surface. Remote sensing combined with geographic information systems (GPS) is often used in Pas. This allows farmers and other agricultural producers to cut costs and maximize profitability by using modern technology rather than traditional on – site approaches. Nowadays, variable rate technology (VRT) is intruded to increase precision farming practices. VRT is a vital component for PA and is becoming more prevalent for large landholders. In VRT, collections of dynamic field information and other input data are useful in defining the appropriate input amounts of the required chemical inputs. [5] Hence the demand for precision agricultural techniques, valuable products, fine RS information as well as VRT has grown tremendously. The latest developments in Earth observation (EO) technology and platforms for PA are discussed,

with particular focus on the use of hyperspectral sensors for this purpose. As part of this, with a particular focus on hyperspectral sensors, we provide useful information for identifying research challenges, limitations, and advantages of various structures and sensors for PA.

## II System Implementation

In the proposed system we use an HRFLM (Hybrid Random Forest with a linear model) algorithm for prediction works. The proposed system used an ensemble voting classifier for hybrid random forest and linear model. Due to the architecture of the hybrid algorithm, high accuracy for prediction was achieved. The prediction accuracy reached 96%. As figure 2 represent the proposed system architecture.



**Fig 2. Proposed System Architecture**

### 1. Data Collection

The precision agriculture dataset was collected from the Kaggle website. This dataset consists of over 5000 data and has features such as soil moisture, temperature, humidity, wind speed, fertilizer, and humidity.

## 2. Data Pre – Processing

At first, the dataset is fetched by using the pandas library and then save the data inside a pandas data frame. At first, this dataset consists of lots of null values, then drop all the null values because machine learning model cannot be able to process null values.

## 3. Random Forest Algorithm

Random Forest is a popular supervised machine learning algorithm for classification and regression problems. Build decision – making trees from different samples and take their majority vote to split and rate in the event of a decline.

One of the most important features of the random forest algorithm is that it can handle the data set containing variables as in the case of regression and categorical variables as in the case of classification. It gives the best results for classification problems. Below steps are described from the figure 3.

### Steps involved in random forest algorithm

- Step 1: Take n random records from a dataset containing k records from a random forest.
- Step 2: A separate decision tree is built for each sample.
- Step 3: Each decision tree is built for each sample.
- Step 4: Final results are calculated based on majority or mean for classification and regression, respectively.

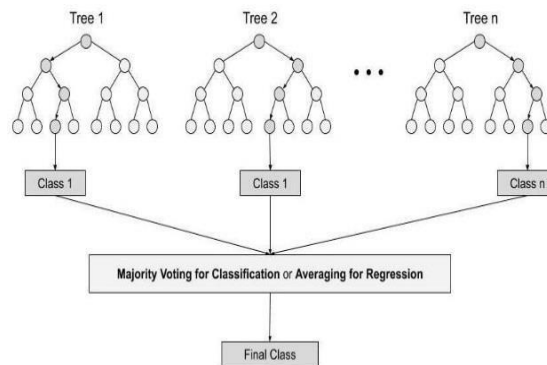
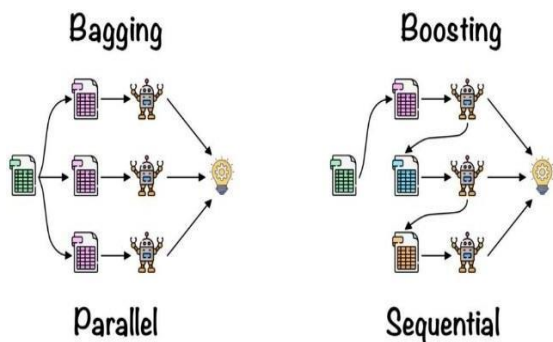


Fig. 3 Random Forest Classifier

## 4. Ensemble Classifier

Before understanding the function of a random forest we must look at the integration process. [6] Ensemble simply means combining multiple models. Therefore, a set of models is used for prediction rather than a single model. Ensemble uses two types of methods as figure 4:

1. Bagging – Another training subset is generated by substituting from the sample training data, and the final result is based on a majority vote. Random Forest for example.
2. Boosting – It combines weak learners with strong learners by creating sequential models such that the final model has the highest accuracy. For example, ADA boost, XG boost.

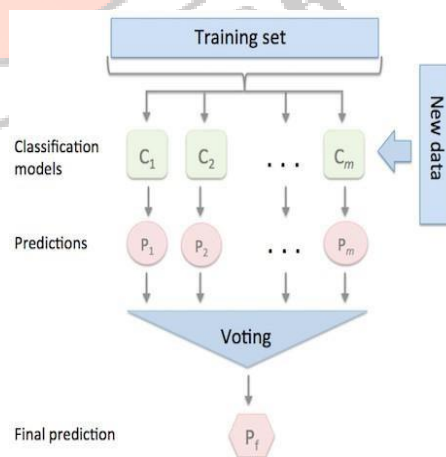


Fig 4. Types of Ensemble Methods

### Bagging:

Bagging, also known as bootstrap aggregation is a compilation method used by random forests. Bagging selects a random sample from a data set. So, each model is built

from a sample provided by the source data (the bootstrap sample) and has a fallback called getting rows. This step of getting rows by replacement is called bootstrapping. Now each model is independently trained to produce results. The final result is based on a majority vote after combining the results of all models. This step of combining all the results and producing an output based on a majority vote is called aggregation as figure 5.

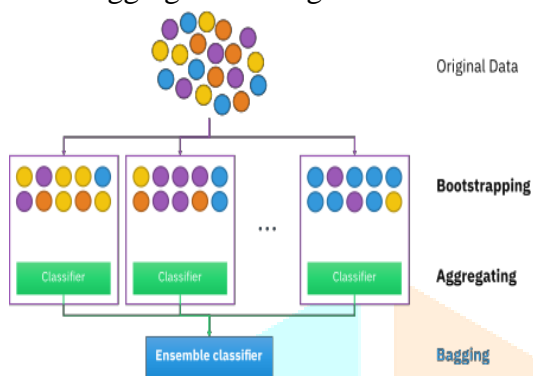


Fig 5. Ensemble Classifier

**Ensemble Voting Classifier:**

An ensemble voting classifier is a metaclassifier for combining similar or conceptually different machine learning classifiers for majority or multiple vote classification. (For simplicity, both majority voting and majority voting are referred to as majority voting).

The Ensemble Vote Classifier uses “hard” and “soft” voting. In hard voting, we predict the final class label predicted most often by the classification model. In soft voting, we predict the class labels by averaging the class – probabilities (only recommend if the classifiers are well – calibrated). The figure 6 shows that the representation of ensemble voting classifier.

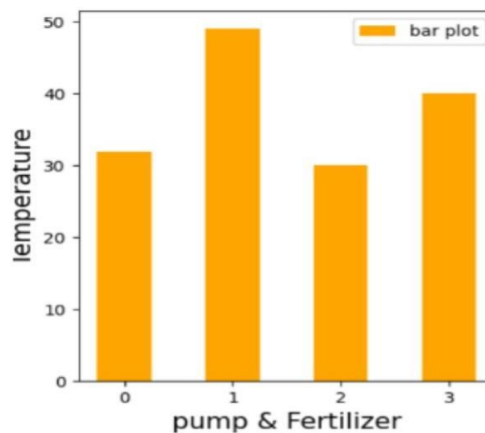


Fig 6. Representation of Ensemble Voting Classifier

**Hard voting:**

Hard voting is the simplest care of majority. Here, we predict the class label  $y^{\wedge}$  via majority (plurality) voting of each classifier  $C_j$  :

$$y^{\wedge} = \text{mode} \{C_1(x), C_2(x), \dots, C_m(x)\}$$

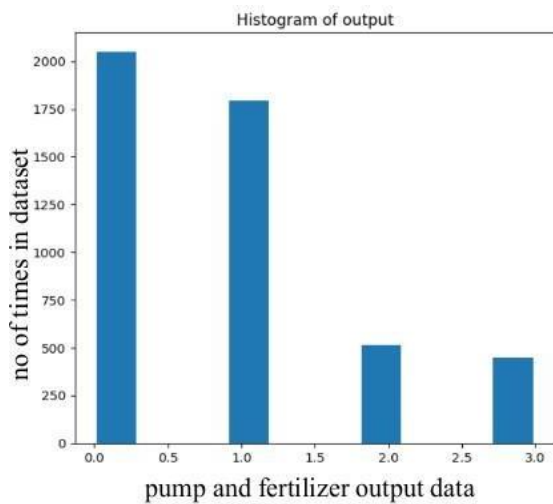
**III Results and Discussion**

Fig 7. Bar plot analysis of temperature and pump & fertilizer

In the figure 7, takes the pump and fertilizer on the x – axis and the temperature on the y – axis. It shows the value of the pump and fertilizer. If the temperature is high, then the value of the pump and fertilizer will be 1. If the temperature value is 40 then the value of the pump and fertilizer will be 3.

Histogram means the frequency of occurrence. This graph shows how many times a particular value occurs in the dataset. In this figure 8, the system takes pump and fertilizer as the x – axis and the number of times occurred in the dataset as the y – axis. Here 0 has occurred 2000 times.





**Fig 8. Histogram analysis of pump and fertilizer with datasets**

The model (or “separator”) withinside the facts set to check its actual values is known. The classifier made a tool out of 165 predictions (eg 165 patients were tested for this disease).

The confusion matrix is often used to describe the performance of the classification as figure 9.

```
Python 3.7.6 Shell
File Edit Shell Debug Options Window Help
File "C:\Users\ACER\AppData\Local\Programs\Python\Python37\lib\site-packages\
Klearn\linear_model\logistic.py", line 818
extra_warning_msg= LOGISTIC_SOLVER_CONVERGENCE_MSG,
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
https://scikit-learn.org/stable/modules/linear_model.html#logistic-regressio
n
ypred :
[0 0 1 ... 1 1 1]
ytest :
[0 0 1 ... 1 1 1]
Confusion Matrix :
[[507  0  0  0]
 [ 0 471  0  0]
 [  0  0 122  0]
 [  0  0  0 100]]

Please Enter the User ID : user
Please Enter the Password : 12345678
User Id and Password are Matched
Enter a list elements separated by space : 8 90 30 80 7

user list is ['8', '90', '30', '80', '7']
[8.0, 90.0, 30.0, 80.0, 7.0]

Water should be in off condition
For the given dataset the water should be in off condition
Enter a list elements separated by space : |
```

**Fig. 9 Output of a confusion matrix**

### III Conclusion and future work

In this paper, we used a hybrid random forest and straight model algorithm to predict the status of the load as fertilizer and pesticide. We used accuracy Agricultural data holding more than 5000 data for training purposes. After training, predicts the state of the load using a

mixture a random forest with a straight model. It archives more than 96% accuracy during testing and training. Predicted the results of our hybrid algorithm are accurate and stable, its patterns are also consistent with existing data set patterns. And which is why our model is fully trained as well can predict load status higher stability. Our future job is to improve accuracy through deep learning.

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