

# ***Smart Plant Care – A Fuzzy Model for Plant Disease Detection***

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**Abstract:** A Fuzzy inference model is presented in this work for monitoring the rate of plant growth. To anticipate if a plant or its leaves will have a disease, the Fuzzy logic makes use of hybrid ensemble learning approaches. The suggested method will combine the information gathered from taking 2,000 pictures, use fuzzy logic and various machine learning algorithms, and forecast the best crops based on the state of the environment. This gives young farmers access to a wide range of crops that they can grow. The creation of computer programs that can access data and learn on their own is the focus of machine learning. One of the most challenging problems in precision agriculture is plant disease prediction, and various models have been put forth and proven to work thus far. This problem requires the use of different datasets since plant diseases are influenced by a number of factors, including soil, fertilizer usage, seed variety, climate, and weather. This implies that identifying plant diseases involves a number of intricate processes rather than being a straightforward procedure. The foundation of the agricultural system is the farmer. Since a nation's gross domestic product must be equitable, as is well known, agriculture plays a significant role in its development. Because crops need to be produced and processed for the agricultural system to function, farmers are essential to its success. To help these farmers, a fuzzy model of a real-time plant disease prediction combined with hybrid machine learning and data analytics is developed for monitoring the plants in a smarter way.

**Keywords:** Smart Plant Care, Fuzzy Model, Plant Disease Detection, Machine learning algorithms

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## **Introduction**

This work presents a Jupyter Notebook with a machine learning model. Hybrid ensemble learning techniques are used in the Python business logic to predict whether a plant or its leaves will be ill. The proposed approach will employ machine learning algorithms, aggregate data from 2,000 photos, and predict the optimal crops based on environmental conditions. Young farmers can now cultivate a variety of crops thanks to this. Machine learning focuses on developing computer algorithms that can access data and learn on their own. Plant disease prediction is one of the most difficult issues in precision agriculture, and several models have been proposed and shown to be effective so far. Since a range of factors, such as soil, fertilizer use, seed type, climate, and weather, influence plant diseases, this challenge necessitates the use of several datasets. This suggests that diagnosing plant diseases is not a

simple process but rather entails several complex steps. The farmer is the cornerstone of the agricultural system. Agriculture is important to the development of a country because, as is widely known, the gross domestic output of a nation must be equitable. Farmers are vital to the success of the agricultural system since it depends on the production and processing of crops. A Python prototype of a real-time plant disease prediction tool that blends data analytics and hybrid machine learning was created to assist these farmers. Machine intelligence is a subset of artificial intelligence.

The aim of this work is to focus on one of the main challenges in agricultural land i.e., disease prediction. The disease in crop plants affects agricultural production, so a model is proposed to automate a method for the prediction of disease in the plants.

## **Motivation**

Farmers sustain the agricultural system. It is common knowledge that agriculture plays a crucial role in a nation's development. A key part of India's economy and labor market is agriculture. Not selecting the right crop for their soil is one of the most frequent issues Indian farmers deal with. Failing to promptly safeguard crops and plants against illnesses is one of the most common problems among the Indian farmers to deal with.

## **Problem Statement**

Plant diseases have become a problem because they can drastically lower the quantity and quality of agricultural products. Automatically identifying plant illnesses is a crucial area of study since it could be useful for tracking vast agricultural fields and identifying disease symptoms as soon as they show up on plant leaves. The suggested system is a software program for automatically identifying and categorizing illnesses of plant leaves. First, a color transformation structure for the RGB input image is created. Next, the green pixels are masked and eliminated using a predetermined threshold value. Next, a segmentation process is carried out, and the texture statistics for the relevant segments are calculated. Lastly, the extracted features are fed into the classifier. The process for identifying and categorizing leaf diseases involves deleting and masking green pixels, extracting the affected area using a predetermined threshold, and using a standard simulation package to calculate texture statistics to assess the diseases.

## **Data collection**

The dataset used in this research is sourced from the Kaggle data set collection. In this study, the present DiaMOS Plant, an expanded dataset examined in [5], a field dataset for diagnosing and tracking plant illnesses. For the purpose of creating a representative sample that encompasses the primary cultural features of this plant, DiaMOS Plant is a pilot dataset that includes photos of a pear tree's full growing season, from February to July. The dataset can be used for classification and detection tasks using machine and deep learning techniques. A total of 3505 photos were gathered, of which 499 were of fruit and 3006 were of leaves. Fruit set, nut fruit, fruit growth, and ripening are the four stages that the fruit goes through. Likewise, there are four types of biotic and abiotic stressors: leaf spot, leaf curl, slug damage, and healthy leaf.

## Literature Survey

The "Fuzzy decision support system for boosting the agricultural productivity and effective use of fertilizers" was presented by Prabakaran, G. et al. explains how fuzzy logic algorithms are used to increase agricultural output while lowering fertilizer consumption. This approach consists of two components: expert knowledge based on land reports to boost the yield potential by adding the right organic matter to the soil that is deficient in minerals. The goal of this research is to increase productivity while using the least amount of fertilizer possible. This study was conducted to evaluate fertilizer use in the AgroClimatic Zone (ACZ) using detailed daily field measurements and three years of laboratory analysis to ascertain the precise fertilizer requirements for each piece of land. To create feasibility guidelines for decision support systems that would help the crops get the desired results, the data was analyzed using MATLAB. The fact that fuzzy logic control systems rely entirely on human knowledge and experience is one of their main disadvantages. A fuzzy logic control system's rules must be updated on a regular basis. These systems are unable to identify the precise yield prediction. Additionally, writing the logic for the entire fuzzy expert system is really challenging. [1].

According to A. Toreti et al., Weather data are crucial for crop monitoring and forecasting, but they are not always available and may have poor spatial representativeness, according to a study that uses "reanalysis in crop monitoring and forecasting systems." Reanalyses are therefore an extra data source that needs to be looked into. The European Commission's Joint Research Centre's scheme, its gridded regular meteorological measurements, the biased-corrected reanalysis AgMERRA, the ERA-Interim reanalysis, and the biased-corrected reanalysis AgMERRA are used in this study to assess the feasibility of reanalysis-based crop tracking and forecasting. Additionally, focus on Europe and two crops—wheat and maize—under potential and water-limited circumstances from 1980 to 2010. They used information from weather stations around Africa to conduct their investigation. For other countries, it might not be sufficient. [2].

The article "Using daily data from seasonal forecasts in dynamic crop models for yield prediction: A case study for rice in Nepal's Terai" was written by Silvio Gualdi et al. The study's findings show that, in contrast to the standard ensemble averaging method frequently employed in seasonal climate forecasting, averaging the simulated yield using individual members does not ensure improved yield prediction. Alternative downscaling techniques and a comparable study for a region with greater agricultural and meteorological data availability and more accurate seasonal forecasts should be included in future studies.[3].

The "Crop Recommender System for the Farmers using Mamdani Fuzzy Inference Model" was created by Kuanr et al. The purpose of this study is to develop a collective recommender system for farmers that uses past months' weather data to recommend a crop suitable for the farmer's location. The suggested framework is implemented using the Mamdani Fuzzy Inference model. The results demonstrate that it provides before crop suggestions before seeding. [4].

The "Crop Selection Method Based on Various Environmental Factors Using Machine Learning" was created by Nishit Jain et al. The suggested approach uses a feedback propagation algorithm to add up the analysis of all the influencing aspects in order to calculate the maximum yield.[5]. The article "A comprehensive review of automation in agriculture using artificial intelligence" by Kirtan Jha et al. discusses the application of various automation techniques, such as IOT, machine learning, and artificial intelligence, in agricultural systems.[6].

### Scope of the work

To use the image factor to predict the relevant plant disease, the following are required to

- make an inference by analyzing the data.
- examine and contrast the cleaned dataset using different machine learning techniques.
- frame the dataset and hybrid ensemble model.

### Methodology

The current technique predicts the ideal crop for a specific plot of farmland using a fuzzy model and expert knowledge. Fuzzy sets are used to reflect expert knowledge about the land, weather, air, and agronomists. The final rules are created with the assistance of professional knowledge. In contrast, the fuzzy technique employs a number of state variables in order to get the intended outcome.

For a fuzzy knowledge-based system to be validated and verified, extensive hardware testing is required. Developing clear, ambiguous rules and membership functions is challenging. The terms fuzzy temporal logic and probability theory are sometimes confused. The rules of a fuzzy logic control system need to be changed frequently. An exact yield estimate cannot be recognized by these technologies. Moreover, it is quite challenging to write the logic for the entire fuzzy expert system.

To forecast higher agricultural yields, we will employ the hybrid ensemble technique in this suggested approach. The sole NPK (Primary Nutrients) that the system uses is to indicate the fertility of the soil (as illustrated in fig. 1). Additionally, temperature, humidity, average rainfall, and pH are the main factors that impact greater crop growth. This will indicate the kind of crop that might grow well in that soil.

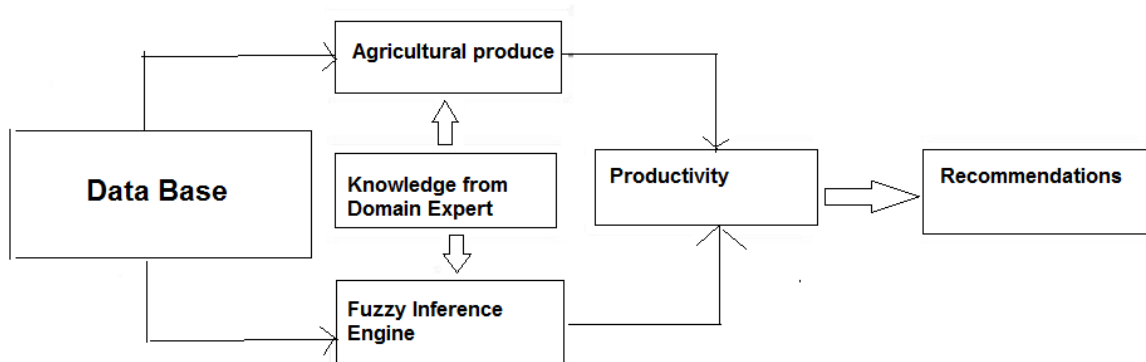


Figure 1. Block Diagram for Fuzzy model in smart plant care

## Results and Discussion

A classification algorithm is logistic regression. It's a method for predicting a binary outcome from a series of independent variables. This is a linear model. In linear model we will be having Linear Regression as well as Logistic Regression. Basically the linear regression was used for Regression problem which means the target variable in the dataset will be numerical variable. But in case of logistic regression which is also a linear model but it is used for linear classification problems. It can be classified into one of two classes. This is true for binary logistic regression, a form of logistic regression. It can be classified into one of two classes. This is true for binary logistic regression, a form of logistic regression. It will segregate the output in the 's' shaped graph so that the prediction will be made based on that graph internally.

Machine learning model that can achieve high accuracy in a variety of tasks while also being very easy to understand. What distinguishes decision trees from other ML models is their consistency of knowledge representation. A decision tree's "information" is explicitly formulated into a hierarchical framework after it has been educated. This structure organises and displays information in such a way that even non -experts will understand it. Induction and Pruning are the two steps used to construct Decision Tree models. Induction is the process of actually constructing the tree, which is, setting all of the hierarchical decision boundaries based on the data. Because of the nature of training decision trees they can be prone to major overfitting. Pruning is the process of removing the unnecessary structure from a decision tree, effectively reducing the complexity to combat overfitting with the added bonus of making it even easier to interpret

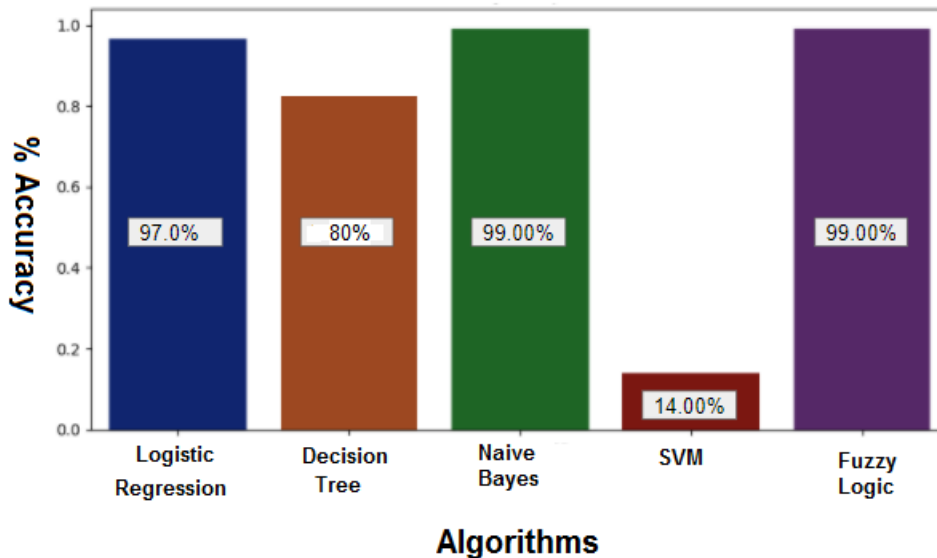


Figure 2. Comparative Analysis output for Smart Plant Care model

## Conclusion

The comprehensive evaluation of machine learning algorithms in this study reveals Fuzzy model as the most effective approach for plant disease classification within Smart Plant Care. Fuzzy model consistently outperforms KNN and Naive Bayes across metrics, achieving an impressive accuracy of 99% and demonstrating superior precision, recall, and F1-score. Leveraging its ensemble learning and feature

selection capabilities, Fuzzy model proves pivotal in accurately identifying diseases and capturing a high percentage of actual cases. These findings emphasize the critical role of algorithm selection in developing reliable plant disease detection systems. By harnessing the strengths of Fuzzy model, Smart Plant Care offers farmers and agricultural stakeholders a dependable tool for monitoring and managing plant diseases, thus contributing to enhanced agricultural practices and productivity.

Looking ahead, further optimizations and exploration of alternative approaches, such as extensive hyper-parameter tuning and the integration of deeper learning architectures like CNNs, hold promise for enhancing performance. Through continuous refinement and innovation, Smart Plant Care remains poised to advance plant disease detection and management practices, effectively addressing the evolving challenges of modern agriculture.

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