International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 05 May 2024
Page No: 1237 - 1242
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0170

Crop Recommendation System Using Machine Learning Algorithm

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Abstract
This study aims to develop an intelligent agricultural yield recommendation framework leveraging the capabilities of AI algorithms. The proposed framework takes yield efficiency and optimal growing seasons as crucial factors in generating appropriate crop recommendations. We have put forth four widely used models, namely Linear Regression (LR) and Multi-Layer Perceptron (MLP), which were trained and evaluated on a comprehensive dataset comprising historical agricultural data encompassing various features such as climatic factors, soil properties, and geographical variables. Furthermore, the data was segmented based on seasonal patterns to provide crop suggestions tailored to specific time periods. The performance of these models was assessed using standard metrics, and an ensemble approach was considered to enhance the system's robustness. Ultimately, the developed framework offers farmers and agricultural professionals a valuable tool for making informed decisions, optimizing crop selection, and enhancing overall agricultural productivity.

Keywords: *Multilayer Perceptron, Machine Learning, Data Processing*

1. Introduction

A recommender framework is a kind of information filtering system that is carefully designed to provide recommendations for relevant products to users based on their past actions, interests, and preferences. By providing tailored recommendations, these systems are frequently used on a variety of online platforms to improve user experience and increase customer happiness and engagement. Recommender systems are used in different types of industries, such as virtual entertainment, e-commerce, online streaming services, and content platforms.

1.1 Machine Learning

Machine Learning (ML) is a subdomain of artificial intelligence (AI) that focuses on creating models and algorithms that enable computers to learn and improve their performance on a given task without explicit programming. Enabling computers to recognize patterns, make judgments, and resolve issues based on data instead than only depending on explicit instructions from programmers is the core idea of machine learning (ML). Machine learning (ML) algorithms are trained on past data and experiences to find patterns and links in the data. These patterns and relationships may then be used to forecast the future, categorize new data, or improve decision-making.

1.2 Precision Agriculture

Precision agriculture is an advanced agricultural method that uses cutting-edge technology to increase yields, improve efficiency, and allocate resources optimally while minimizing environmental effect. Fundamentally, precision agriculture uses a wealth of data from sensors, drones, and satellites to accurately target specific plants or areas within fields with agricultural practices. With the use of this data, farmers are better equipped to make decisions about crop selection, irrigation, fertilization, and pest control. As a result, input prices are lowered, crop quality is improved, and sustainable agricultural methods are encouraged.

2. Literature Review

Alexandros Oikonomidis [1] et.al. Has proposed in this paper, profound Learning has been applied for the harvest yield expectation issue, be that as it may, there is an absence of deliberate examination of the investigations. Thusly, this study means to give an outline of the best in class utilization of Profound Learning in crop yield forecast. We played out a Deliberate Writing Survey (SLR) to recognize and break down the most pertinent papers. We recovered 456 significant investigations of which we chose 44 essential examinations for additional investigation in the wake of applying determination and quality evaluation models to the important examinations. An exhaustive investigation and union of the essential examinations were performed as for the key inspirations, the objective yields, the calculations applied, the highlights utilized, and the information sources utilized. We saw that Convolutional Brain Organization (CNN) is the most widely recognized calculation and it has the best exhibition as far as Root Mean Square Blunder (RMSE). One of the main difficulties is the absence of a huge preparation dataset and hence, the gamble of over fitting and subsequently, lower model execution by and by. For scientists in this field, it is significant to demonstrate the flow difficulties and the opportunities for additional exploration, since they will generally zero in on the significance of missing examination points. Our perceptions with respect to this study are useful for analysts in this field as well as for specialists who might want to foster novel harvest yield expectation models for their own use. A. K. Tripathy [2] et al. have suggested in his study that information-driven precision farming viewpoints—particularly the nuisance/sickness the board—need strong harvest climate data. A study was conducted in a semi-arid area to understand the relationship between yield and climatic bugs and illnesses. The study used distant, tangible, and field-level reconnaissance data on closely connected and dependent vermin (Thrips) and disease (Bud Rot) components of groundnut crops. The information was transformed into useful data, information, relationships, patterns, and connections between the yield climate bug and sickness continuum by using information mining techniques. These components, which were obtained using information mining techniques and generated using numerical models, were validated by comparing reconnaissance data. The information obtained from the rabi seasons of 2009–10 and 2010–11 (post storm) and the kharif seasons of 2009–2010 (rainstorm) might be used to create a real, approachable, emotionally supporting network for expectations related to bugs and illnesses. There has been a significant increase in yield disease and insect contamination recently, along with a higher degree of sincerity, which has caused the workers to suffer enormous financial losses. Crop losses resulting from pests and diseases are widespread, particularly in India's semi-arid climate. Ramesh Babu Palepu [3] et al. According to this theory, agriculture is the most fundamental activity that satisfies the global need for food; it is especially important in emerging nations like India. Applying data mining techniques to agriculture, particularly regarding soils, can boost crop yields and make pledges more accurate. To resolving various difficulties pertaining to the agricultural area, soil analysis is an essential tool. This article discusses the function of data mining from the perspective of soil analysis in the agricultural sector. It also various data mining techniques and the associated work done by various authors in the context of soil analysis. When it comes to soil analysis, data mining methods are quite modern. Today's society uses data mining extensively, and there are a plethora of readily available off-the-shelf tools, techniques, and procedures, as well as sphere of impact on data mining application software. However, research on data mining in agricultural soil datasets is still in its infancy. V. Rajeswari and others [4]. As this framework suggests, soil is an essential and fundamental part of farming. The goal of the project is to use information mining characterization techniques to predict soil type. Procedures/Results Analysis: Information mining characterization techniques such as JRip, J48, and Credulous Bayes are used to predict the kind of soil. The information is separated from the soil information using these classifier calculations, and two types of soil are identified, such as Red and Dark. Conclusions: Information mining and horticulture information mining are summarized in this study. The conjecture's enlarged Kappa Measurements and more reliable outcomes from this information may be obtained with the JRip model. Application/Improvement: Effective solutions utilizing information mining to increase the accuracy of grouping of massive soil informational indexes may be developed to address the problems in massive amounts of data. In the agricultural industry, information mining (DM) is becoming well-known for its ability to arrange soil, harvest, and annoy executives in no man's land. Inorder to predict the important relationships and assign affiliation rules to different soil types in agribusiness, In1 assessed the range of DM affiliation processes and applied them to the soil science data set. Nabila Chergui [5] et al. argue in their system that recent advances in information and communication technologies have had a substantial influence on numerous sectors of the global economy. The ubiquitous availability of digital devices, as well as advances in artificial intelligence and data analytics, have all contributed to the rise of Digital Agriculture. This new approach to agriculture has brought novel techniques that increase production and efficiency while emphasizing environmental sustainability [6] . The use of powerful digital equipment and data science has enabled the collecting and analysis of large agricultural datasets, allowing farmers, agronomists, and professionals to obtain a better knowledge of farming operations and make more educated decisions. This study provides a thorough examination of the use of data mining tools, especially in the context of digital agriculture. The focus of this research is on agricultural yield management and monitoring, as we look at the many types of data mining approaches used in this field. Furthermore, we look at a variety of existing works that use data analytics in agriculture.

3. Existing System

Tamil Nadu, as a coastal state, grapples with agricultural vulnerabilities that hinder its productivity despite the growing population and expanding agricultural land. Traditional knowledge transfer methods among farmers, previously effective through oral communication, are now limited due to unpredictable climatic conditions. This necessitates the integration of modern IT advancements in agricultural sciences to provide farmers with essential farming information. The application of modern technological methods in agriculture, particularly Artificial Intelligence (AI) methodologies, offers a systematic approach by utilizing available data to create predictive models. These AI methods address various agricultural challenges such as yield forecasting, crop rotation, water and fertilizer requirements, and security measures. Given the variability of climatic factors, there is an urgent need for efficient [7] methods to support crop growth and assist farmers in their production and management practices. This approach is promising for aspiring farmers, offering them enhanced agricultural practices. Recommendations for crop selection, based on climatic factors and yield data, can be provided through data mining techniques. Implementation involves suggesting crops tailored to specific climatic conditions and quantities. Data analysis enables the extraction of valuable insights from agricultural databases, allowing recommendations based on productivity and seasonality, thus providing farmers with actionable insights to improve crop cultivation practices.

3.1 Proposed System

In this work, we present a method for determining climatic quality and predicting the most appropriate yield for development using LR, MLP calculations. We include harvest and climatic data as inputs to our model, and our method also suggests the appropriate manure for the predicted yield. The results of our experiments demonstrate how well our method forecasts crop determination and production, which may be quite beneficial to ranchers. We evaluate each calculation's presentation and compare them to ensure that we are applying the most effective process. We also go above and above to ensure the accuracy and dependability of our material [8]. Our analysis demonstrates that artificial intelligence (AI) can be a useful tool for predicting crop

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production and helping ranchers make well-informed decisions. The system starts by compiling and organizing many information sources, such as real harvest execution data, advice on soil health, meteorological circumstances, and clear sporadic patterns. The approach ensures that the information is robust and instructive for the learning computations by carefully preparing the data and constructing the highlights. All things considered, the proposed framework's user interface is meant to be to comprehend and accessible to ranchers. Ranchers may easily provide information about their region, the characteristics of the soil, and other pertinent details to receive crop ideas that have been customized to their unique situation. Additionally, the framework will continuously learn from fresh data and adapt to maintain its recommendations current with changing circumstances, technological advancements, and horticulture practices.

4. Module Description

4.1 Input Data

Crop production is determined by agronomic and environmental parameters, which are the input data for crop recommendation systems. Numerous sources, such as historical documents, weather stations, field testing, and satellite photography, are used to get this data. Location (latitude, longitude, name), seasonal data, climatic factors (temperature, precipitation, humidity), soil qualities (pH, nutrient content), altitude, and plant growth and production are examples of common input data.

4.2 Data Processing

Preparing the input data for machine learning model training involves a crucial step called dataset preprocessing [9]. To handle missing numbers, outliers, and inconsistencies, data cleansing is part of this process. This could involve methods like data normalization and standardization, outlier detection, and imputation. Preprocessing makes ensuring the input is clean, error-free, and well-formed, which enables the model to learn and forecast with accuracy.

4.3 Feature Selection

The translation of a dataset to suit various machine learning algorithms is paramount for optimizing classifier accuracy. This necessitates the application of distinct feature extraction methodologies, particularly when the class attribute transitions from numeric to alphabetical values. Techniques such as one-hot encoding or label encoding are employed to transform these attributes effectively. Additionally, the dataset is enriched through feature engineering, which may involve creating averages or ratios of scores. These transformed features facilitate the creation of performance class clusters using clustering algorithms like K-Means or DBSCAN. For instance, in an illustrative scenario with student scores in multiple areas, a unique cluster may represent those achieving "excellent" scores across three categories. This analytical approach enables deeper insights into performance trends, fostering the implementation of more targeted interventions.

4.4 Classifier

A classifier is a machine learning method that uses functional data that has previously undergone preprocessing to learn and forecast crop productivity. Multiple classifiers, such as multilayer perceptrons (MLP) and linear regression (LR), can be used in crop recommendation systems. Each classifier has unique benefits and performs well across a range of data types and prediction tasks. Utilizing input variables that describe the weather and location of a sss 1 specific place and season, the trained classifier produces an output that represents the expected crop productivity in that situation.

5. Algorithm Details

5.1 Multilayer Perceptron (MLP)

An MLP is a type of artificial neural network that learns from training data by backpropagation. It is composed of multiple layers of nodes, or neurons. To offer predictions, nodes in the hidden layers process the attributes (such soil type, temperature, and humidity) that are represented by every node in the input layer. The output layer provides the final forecast, which could be a classification task (crop kind, for example) or a regression work (crop yield, for example).

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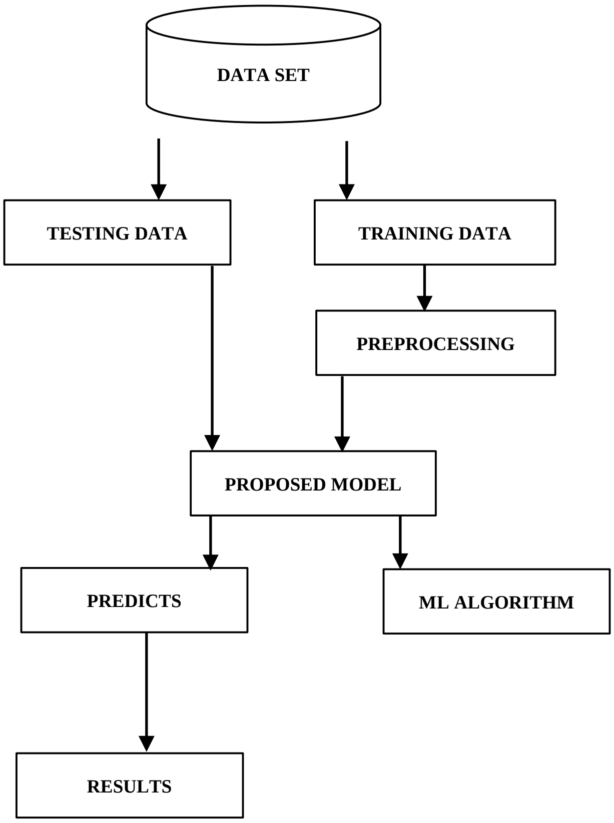

Figure 1 Block Diagram

5.2 Linear Regression (Lr)

A well-liked and simple method for regression-related applications is LR. The link between a dependent variable and one or more independent variables is modelled using a linear equation.

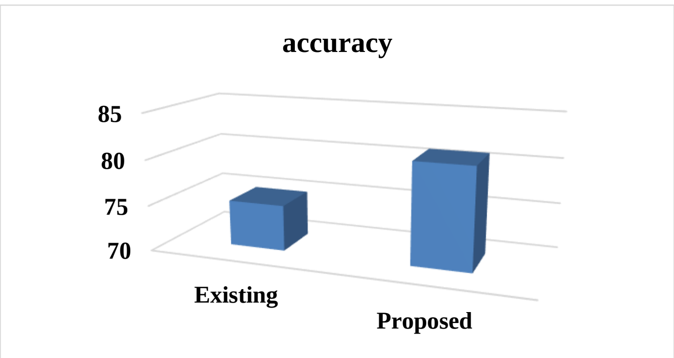

Figure 2 Comparison Graph

In the framework of a crop recommendation system, LR can predict crop yields by accounting for factors including soil type, temperature, and rainfall. It can also be used to figure 2 predict other variables linked to continuous crop growth, such as the amount of water or fertilizer required.

Step1: Again, the entire workout set is split into two sets. (train and holdout)

Step2: Train the initial part (train) of these selected basic models.

Step-3: Test them with these condition part. (holdout)

Step-4: Currently, the accuracy is determined using the results of the prediction test.

6. Result Analysis

We evaluate the performance of the suggested approach against the current agricultural crop recommendation system, which attains 75% accuracy, and find that it performs far better, at 81% accuracy [10]. It's clear that the newly installed technology can forecast more accurately. The proposed algorithm provides more accurate crop predictions than the existing approach. It uses a sizable dataset that includes seasonal components and may make use of MLP and LR.

Table 1 Comparison Table

Algorithm	Accuracy
Existing	75
Proposed	81

This increase in accuracy shows that the recommended approach may greatly enhance the decision-making skills of farmers and agricultural specialists, which would ultimately result in better crop selection and higher levels of overall agricultural productivity table 1.

7. Future Work

To boost its efficacy and influence, the intelligent agricultural crop recommendation system can be further enhanced in the future. First off, merging satellite images with current weather data can enhance the system's accuracy in capturing dynamic environmental changes. Second, more advanced techniques and machine learning algorithms, such as ensemble approaches and deep learning, may produce more accurate and consistent forecasts.

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Thirdly, expanding the system's reach to include guidance on crop disease detection and pest control can offer farmers comprehensive support. Lastly, collaboration with regional agricultural research centers and farming communities can aid in incorporating knowledge unique to a particular region, increasing the system's adaptability to a greater range of agricultural sites and farming practices.

Conclusion

In summary, the proposed intelligent crop recommendation system provides a powerful tool to support farmers and other agricultural professionals in making educated decisions and optimizing crop productivity. The system uses powerful machine learning models (LR, MLP) to create data-driven, season-specific crop recommendations based on historical agricultural data and significant environmental variables. The user-friendly interface ensures ease of use and engagement by allowing farmers to enter relevant data and obtain tailored crop suggestions based on their specific region and growing season. This strategy has several benefits, including better crop selection, increased yield, efficient use of time and resources, and support for sustainable agriculture practices. With a focus on continuous improvement through regular updates and maintenance, the system is kept accurate and up to date, providing farmers with reliable insights that increase yields and profitability. Ultimately, crop recommendation systems have the potential to provide farmers with cutting edge tools that guide them toward more resilient, efficient, and environmentally friendly agricultural practices. With this innovative approach, agriculture can thrive and support sustainable development for a better future, as well as food security.

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