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Fertilizer Estimation using Deep Learning Approach

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Abstract

Indian economy is dependent on agriculture and allied activities. The Percentage of population directly or indirectly involved in agricultural actives is more. Due to increase in population and demand for food supply, a large quantity on fertilizers are used in soil, which may result in soil pollution and also degradation of soil quality which may lead to multiple problems for future generations. It is essential to analysis the amount of fertilizers required for a particular crop with respect to the fertility of the soil. Traditionally soil testing is carried out in laboratory and the quantity of fertilizers are recommended by soil science department, but the process takes longer period of time and many farmers do not adopt this method. So it is essential to overcome the problem using advanced technology. The gap between technology and farmers should be bridged.A recommendation system is proposedto predict the amount of fertilizers for a particular crop banana and regression methods for upcoming plantations using Neural Networks . The major soil nutrient are Nitrogen (N), phosphors(p), and potassium (k) plays the major role in crop growth. By default soil contains particular amount of NPK, it varies from place to place. The requirements for each crop also vary. In this paper, a model is structured to recommend the amount of fertilizers required for the crop banana.

Keywords: Agriculture, fertilizers, crop banana, machine learning, neural network.

Introduction

Agriculture is the backbone of the Indian economy which is constrained by poor soil fertility [11]. The World Bank study report states that agricultural development is the effective tool to eliminate poverty and enhance shared prosperity and feed nine billion people by 2050 [5]. In general, agriculture is the step by step procedure such as ploughing the soil, planting, maintain effective fertilizer, pest control to get good yield [5]. The soil fertility should be classified to predict the amount of fertilizers required for a particular crop with respect to the soil fertility. Soil nutrient is the most essential factor for enriching soil fertility. The traditional methods for evaluating soil nutrient are complex to operate and generating more difficulties in the practical applications [3]. It is highly observed that farmers could able to produce effective results if they get sufficient information in a timely manner [6]. In addition to this, the funds were increased by 24% to generate several reforms in rural area in the year between 2017 and 2018 [6]. The village wise soil data were gathers from the soil science department and the data were pre-processed. In traditional method, a farmer has to approach the soil science laboratory with the sample soil to get the details about the soil fertility, this procedure is expensive and time consuming. A detailed study is carried out in the banana crop and a recommendation system is developed. The amount of fertilizers required for the banana crop is predicted with the previous available data set. Among the micronutrients required by banana, iron, zinc and boron are found to be major yield limiting factors in India [4]. Many researcher works were carried out to classify the soil and provide the appropriate amount of fertilizers required for the crop. In [12], the soil test report is used to categorize

the important soil features like soil fertility index of Available potassium (K), Organic carbon (OC), Boron (B), Available Phosphorus (P) and Soil reaction (pH). Classification problems are solved with help of learning classification method like Extreme Learning machine (ELM) with various activation functions such as hyperbolic tangent, Gaussian radial basis and hard limit, triangular basis and sine squared [12]. In most of the classification the Gaussian radial basis performed better by providing 80% accuracy. A decision support system was developed using machine learning methods to monitor soil, crop and climate in precision agriculture was carried out in [13], the output recorded were designed as a set of decision rules to monitor the field.

Due to improper crop and soil management strategies, agriculture experiences loss in soil quality. Over usage of chemical fertilizers have generates inadequacy in the availability of soil nutrients. In the recent times, artificial intelligence models are used to forecast the composition of nutrients. However, the deep learning and machine learning approaches suffer from drawbacks such as, high time consumption for training and high usage of memory space. Hence, there is still a scope to enhance the classification models' performance in terms of accuracy of classification, time consumption, and memory consumption.

The crop selected for the study is banana; the location is southernmost part of Tamilnadu. The district is located in high rainfall agro climatic zone. The district has horticultural crop area of 65804 hectares in which plantation crops (84%) has significant areas like Spices (3%), fruits (10%), flowers (0.2%) and vegetables (1%). The banana crop occupies 4218 Hectares. Banana is a yearly crop, it takes over 360 days to harvest the crop. The fertilizers are applied periodically four times for the entire planation. Traditionally a blanket amount of fertilizers are used on the soil, this may degrade the soil fertility. Over use of fertilizers also create many hazardous outcomes to the human community. There is a need to overcome the problem. Because of different needs of crops and varieties and soil types, the prediction of exact amount of fertilizer required for yielding crops become difficult [13].

Related Work

Different works were carried out using different methods to analyse the fertilizers in the soil, most of the work are focused on the macro and micro nutrient available in the soil. Properties such as total nitrogen, organic carbon, phosphors, pH, clay content, texture and thickness are considered in [2] and a decision tree is constructed. In [2] the authors also have focused on environmental factors by which the soil fertility may change. Once the association between soil and environmental factors are accomplished, such link generates a way to soil properties from the local environment [2]. The study performed by the authors in [2] offers a sensible prediction in soil properties like total phosphors, clay content and pH but it does not offer feasible outcome in physical properties like heat capacity, bulk density and water capacity.

Author proposed an application of support vector machines in classifying the soil type and evaluating the values of soil properties as per the known values of specific physical and chemical properties in sampled profiles [8]. To automate the task of classification of soil different classification approaches were implemented by different authors. In [8] Linear support vector machine (LSVM)

approach has significant benefits than linear methods in classification of soil properties. In regression, the acquired results implicates that linear methods are not used to determine the values of physical properties with estimated chemical properties [8].

The process of selecting crop is very essential to enhance the maximum yield of a crop from available resources. A crop selection method (CSM) was proposed in [9]. The selection of crop can maximize the net yield rate, there are different parameters that can affect the yield of a crop. Some of the major factors are the geography of the region, weather condition, soil type, soil composition, and harvesting method [9].

A study was determined to evaluate the nitrogen status in the soil for rice plantation. Nitrogen is the most crucial nutrient for plant growth and it occupies the higher ratio in the fertilizer applied, so it is essential to track the nitrogen amount periodically. With the help of visible and near infrared reflection spectroscopy, the estimation of nitrogen in rice were performed [15]. The outcomes revealed that LS-SVM was performed better than non-linear and linear techniques in forecasting the soil plant analysis development (SPAD) values of rice [15].

The author used the chemical soil measurement to categorized relevant soil parameters like phosphorus pentoxide (P_2O_5), fertility indices of organic carbon (OC), soil nutrients nitrous oxide (N_2O), potassium oxide (K_2O), iron (Fe) and manganese (Mn), to suggest the preferable crop and exact amount of fertilizers [11]. These classification problems are determined by using twenty diverse classified and chosen by their high performance of boosting, decision trees, bagging, random forest, neural networks, nearest neighbors and support vector machines. Followed by SVM, Gaussian learn machine and Adaboost, the random forest performs effective performance for six of ten problems and attain 90% of performance in all cases[11].

In [7], the formulation of amount of fertilizers needed for crop management, germplasm, soil nutrient supply was made by nutrient expert. Nutrient expert is a computer based decision support system that allows the advisers to create area specific fertilizer recommendation as per the yield respond to nutrient and fertilizer use [7]. The total amount of fertilizers required for a crop is calculated by evaluating the following parameters such as using fertilized at critical growth stages and optimal rates to makes deficit between the nutrients supplied from the soil and nutrient needs of crop, apply the total nutrient for crop need requirements to the larger area or particular field with growing conditions, net P and K for harvesting to manage the long term process for checking status of soil fertility for crop production [7]. The nutrient expert decision support system helps in increasing the agronomic efficiency and balanced fertilization of nutrient inputs. It manages high yield at low fertilizer input costs than the present recommendation techniques [7].

One among the major factors that plays an important role in agriculture is the crop yield. In [1] the authors have focused on the yield prediction of the crop by considering the previous data. The major factors that play an important role in crop yield are considered for the study, data set like crop, crop yield dataset, crop nutrients, location and soil were gathered from other sources like agricultural websites [1]. Here, the most trending and emerging machine learning techniques were used for

predicting the crop yield. Random forest and Support vector machine (SVM) were preferred to attain expected outcome. Soil classification random forest is effective which generates accuracy of 86.35% compared to SVM. In case of crop yield prediction, SVM works better and generates accuracy of 99.47% than Random forest [1].

In [3] prediction of soil nutrient is determined by using the techniques like Artificial neural network, multiple linear regression and support vector machine. The outcomes revealed that average prediction accuracies of support vector machine models were 83% and 77.87% respectively. In addition to this, the average prediction accuracy of General regression neural network is 92.86% which indicates that GRNN and SVM models are used to determine the soil nutrient level with appropriate dependent variables [3].

Machine learning is considered to be a vital tool for predicting the amount of potassium, phosphorous and nitrogen [10], the challenging part is that different crop and different soil requires different amount of fertilizers. The data has been gathered from soil science institutes, soil reports and agriculture institutes of India [10]. The study was carried out in wheat crop, CART regression was preferred to be the best fit model [10].

Materials and Methods

The main aim of the proposed work is to bridge the gap between farmers and the technology by providing better accuracy in fertilizer recommendations for a particular crop banana and varieties of banana. The banana plantation is a yearly crop, fertilizers are used four times throughout the plantations. We propose the methods through which the amount of fertilizers required for future direction can also be recommended.

This study proposes a parallel deep learning model in order to conserve the usage of time for execution. The application of GRU cells in the hidden layer of the neural network will greatly conserve the memory usage, since the cells contain internal memory that only keeps the essential data and removes the unnecessary ones. The major role of GRU is short term memory, and they use gates to manage the flow of information. We introduce a new variant of Rectified Linear Unit (ReLU) called the Parameterized ReLU in the hidden layers of the neural network. These functions introduce a new parameter as a slope of the negative part of the function, and thereby improve the accuracy of classification. The overall objective of this study is to create a neural network model to predict and classify the soil fertility indices and pH values.

Table 1 Parameters Taken for Study

Parameters	Expansion
Place	Kanyakumari district, thootukudi district and tirunelvelli district of tamilnadu
pH	pH value of soil

	Acidic -6.5, Neutral – 6.5 to 7.5, alkaline - < 7.5
N	Nitrogen
P	Phosphorus
K	Potassium
Fe	Iron
Mn	Manganese
Zn	Zinc
Cu	Copper

Procedure to be followed for Implementation:

Recommendation: (Classification of Composition)

Dataset should be prepared ready for two classifications: Composition of Micro Nutrients and Composition of Macro Nutrients.

The dataset should be labelled with “High, Medium, and Low” composition.

The dataset should be split for Training and Testing.

The classifier 1 and 2 are trained using training dataset.

Classifier 1: Trained using Dataset 1 which contains micro nutrients.

Classifier 2: Trained using Dataset 2 which contains macro nutrients.

The trained classifiers 1 and 2 are then tested with testing dataset.

Classifier 1: Classifies the composition of micro nutrients.

Classifier 2: Classifies the composition of macro nutrients.

Performances of Classifier 1 and 2 are evaluated in terms of accuracy, sensitivity, specificity, and error rate.The performance of the proposed network can be compared with the performance of the existing state-of-the-art classifiers such as, Decision Tree, Random Forest, and SVM.

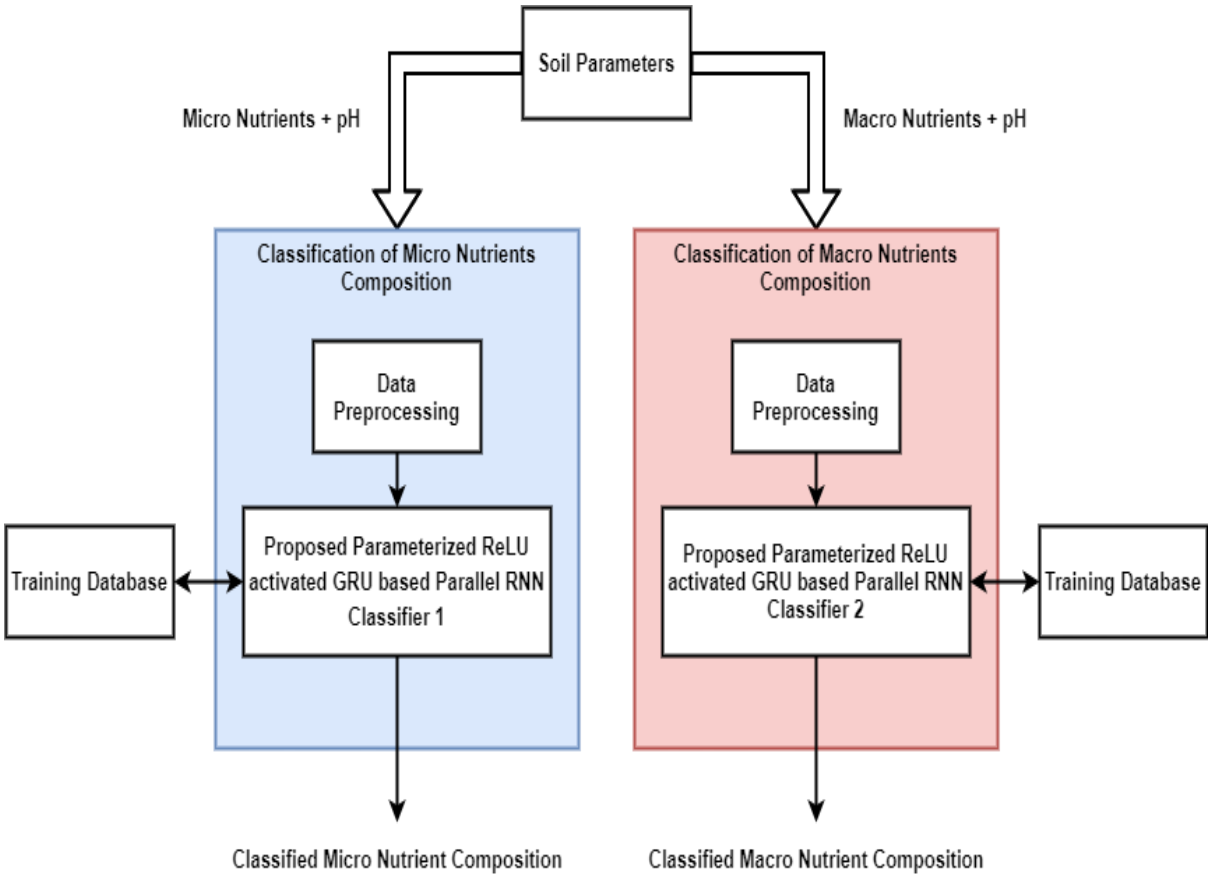

Fig 1 Architecture Diagram of Proposed Work

Conclusion

There is an emerging need to study soil fertility to avoid overuse of soil fertilizers. Here we have proposed architecture to tackle the overuse of fertilizers by providing an outlook to recommend the amount of fertilizers required for the crop banana. There are multiple works experimented by various authors in predicting the required amount of fertilizers using different techniques and methods. SVMs have sets of supervised linear classifiers which have been proposed to solve the issues and have acquired more interest in biological and agricultural engineering [14]. With increase in training time and increase in hidden nodes the network may overfit, which may lead to high accuracy in training the data but can result in poor interpolation in testing of data. It is considered to be a significant problem being evaluated in ANN research and applications [14]. A model is designed to recommend the amount of fertilizer for a crop. In further our proposed work will be compared with the existing state of art to evaluate the efficiency of the proposed work.

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