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Enhanced Machine Learning Approach Used to Analyze Soil Nutrients and Recommending Applicable Fertilizer

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ABSTRACT: In the growth of economy the agriculture plays an important role and the production of the crop is dependent upon some natural factors like water, soil, fertility, etc. The soil fertility is a significant source of nutrients that are needed for plant growth. Machine Learning (ML) is a dynamic approach in the digital world for analyzing large datasets to obtain efficient results through data mining. The proposed system has been taken the soil nutrients of large datasets to suggest suitable fertilizer using advanced machine learning algorithms with data mining. The proposed method of Machine Learning algorithm of Hybrid Quantization Cascaded Neural Network (HQ-CNN) is used to analyze the soil fertility by soil nutrients. In agriculture, Soil fertility is fundamental for crop production, essential to measure the quality of the soil and this depends upon the capacity of soil nutrients. There are three major soil nutrients are nitrogen (N), phosphorus (P), and potassium (K) and this together defined as NPK this is obtained in the soil. The proposed research aims at restoring the levels of Nitrogen, phosphorous, potassium in the soil by measuring the number of nutrients present. This paper focuses on recommending soil fertility by using Machine learning classifier algorithms such as HQ-CNN as a learner for crop production with efficiency and high accuracy through soil nutrients. The machine learning approaches combined with data mining brings out the novel ways in improving the accuracy of classifying soil nutrients analysis to recommend soil fertility. For evaluation propose loss measurement is declared as root relative square error (RRSE), Mean Bias Error (MBE), and statistical measures are noticed.

KEYWORDS: Machine Learning, Data Mining, Soil Nutrients, HQC-NN algorithm, Recommend Fertilizer.

I. INTRODUCTION

In India, a farming method is done traditionally and also the farmers without knowledge of soil and quality of that soil crop yields in traditionally. As a result, they will not gain a satisfactory profit from their farming method. The existing method of testing soil through a manual process will be taking soil samples and sends that for laboratory testing. The manual method will produce various drawbacks like time-consuming, the chance of human error, not so feasible, and sometimes may receive an incorrect report of farming. To overcome the drawbacks this research proposed an automated process for soil fertility recommending through soil nutrients by improved ML techniques. The proposed system will have estimate the nutrients of Nitrogen (N), Phosphorus (P), and Potassium (K) from data analysis tools.

Soil testing is a valuable tool for evaluating the available nutrient status of soil and helps to determine the proper amount of nutrients to be added to a given soil based on its fertility and crop needs. In India, there are several ways to increase economic growth in the field of agriculture. There are multiple ways to increase and improve the crop yield and the quality of the crops through fertilizer. The prediction method also produces a better choice for the farmers utilizing scheduling it, which additionally produces a better outcome.

Particularly, the machine learning (ML) techniques correlate a more strong relationship between the farmers by opting for the factors of soil nutrients and analyzing suitable fertilizer it. Thus, the machine learning technique leads to better prediction. This information is suitable for making decisions about the proper quantity usage of fertilizers, the consumption in terms of variations in fertility levels, and the procedure of fertilizer distribution. The key objective of this research work is to classify soil fertility indices based on the dataset of soil nutrients information through the HQ-CNN algorithm with the data mining technique. This classification can be used in making a soil fertility index analysis report and it would be used to make fertilizer recommendations with the decision support system.

II. RELATE WORK

Veenadhari et al., Influence of climatic factors on major Kharif and rabi crops production in Bhopal District of Madhya Pradesh State were considered. The findings of the study revealed that the decision tree analysis indicated that the

productivity of the soybean crop was mostly influenced by comparative humidity followed by temperature and rainfall. The decision tree analysis shows that the productivity of paddy crop was mostly inclined by Rainfall followed by comparative Evaporation and humidity. For Wheat crop, the analysis shows that productivity is mostly influenced by Temperature followed by relative humidity and rainfall. The result of the decision tree was confirmed from Bayesian classification. The rules formed from the decision tree are useful for identifying the conditions intended for high or low crop productivity.

Mahabadi et al. suggested a method using an artificial neural network that consists of numerous neurons with hidden layer and front/backpropagation units. The author made some modifications to this unit to produce a good yield. As a result, the rate is to be finding out by making a tremendous effect in the hidden layer part. This effect produces more knowledge and results in the overanalyzing of inbuilt learning models. For the execution process, the author opted root mean square error for better results.

Ranjeet et al. used a backpropagation based artificial neural network for analyzing the yield of crops. This contains inbuilt neurons and hence the training is conducted with fault prediction for evaluating the environmental conditions, the factors such as temperature, type of fertilizer, area width are considered for better employable results. This work suggested a future work as collecting less loss-effective parameters, a precise range of layers, picking the appropriate number of neurons by using an optimization algorithm.

Vats et al. examined datasets such as soil, rain, and previous yield. Now, the above-mentioned datasets make to cross-check with the variety of available crops. Hence, they are further classified into various subdivisions using the supervised machine learning method. This method further coincides with a linear regression model. During the classification process, the categories such as low, medium, and high are noted and hence the regression module showed proper crop yield. For supervised learning, some of the techniques such as kernel neural network, support vector machine, and least square support vector machine are used.

III. PROPOSED METHODOLOGY

Soil fertility is a fundamental need for crop production in the field of agriculture and also fertility will show the capacity of plants growing in soil. Famers can yield the crop in a better way and they can make a decision of element changing by using the advanced technology in agriculture. This research defining the characteristics of giving input of soil nutrients for a machine learning algorithm for signifying soil fertility.

- Soil Nutrients Dataset
- Data Pre-Processing
- Machine learning HQ-CNN algorithm
- Feature Extracted
- Data Mining

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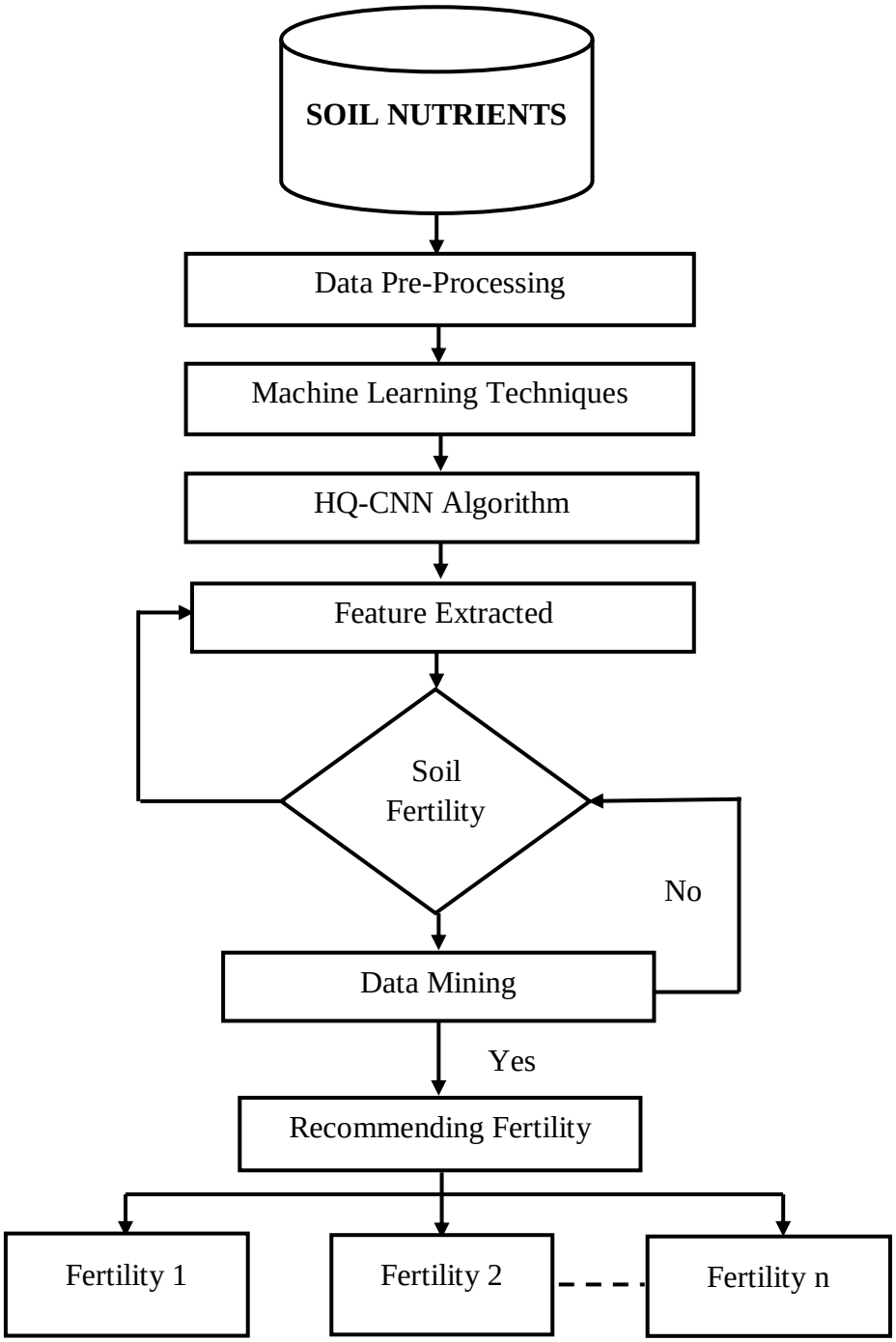


Figure 1: Proposed System for recommending soil fertility

A) SOIL NUTRIENTS DATASET

The soil nutrients data set are available in the UCI repository there are numerous raw dataset are available which are presented with noisy and noisy removal of data. The input of soil nutrients of NPK is the common nutrients that are randomly collected as an input of the dataset. The input of the machine learning technique and the data mining process is used to analyze the suitable fertility for the selected soil area are detecting. This observed the prediction method could be applied efficiently over the optimized parameter of soil nutrients for recommending fertility with high accuracy and less human involvement. Before cultivation, this recommending method helps farmers to yield in the best fit.

B) DATA PRE-PROCESSING

Data Pre-process is a performance that is used to clean data from soil nutrients raw data set. In other words, whenever the format of soil nutrients raw data is collected from different sources which is not feasible to analyze. From the data to extract a meaningful performance to promote a machine learning technique to enhance the quality of gathered data from data preprocessing. The soil nutrients data may be a chance of inconsistency, inaccurate, and incomplete data the proposed system of machine learning is used to neglect the drawbacks. The dataset of soil nutrients is to organize the raw data to make the ready process to execute a machine learning process.

C) MACHINE LEARNING HQ-CNN ALGORITHM

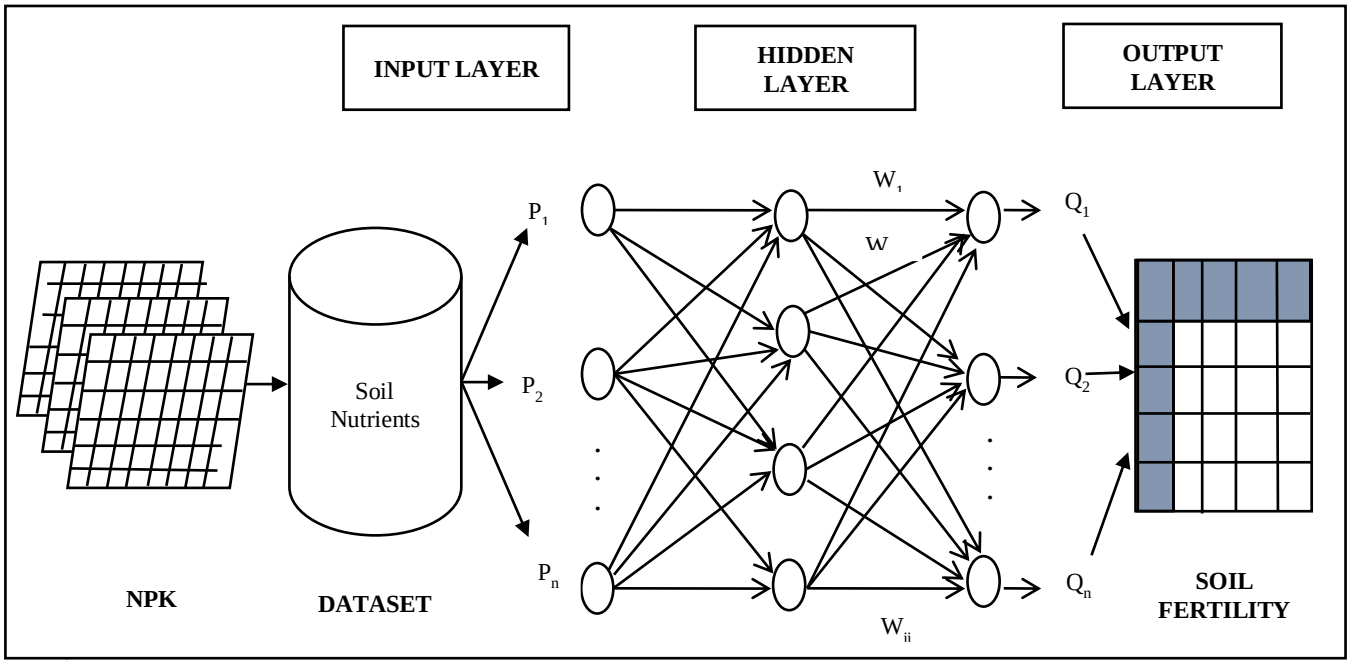
Analyzing soil nutrients of land from data collection for probability analyzing soil fertility. The reasonable way NPK of soil nutrients are feature extracted to provide a necessary fertilizer to make better agricultural production, minimum time complexity, and highly effective. Using a Machine Learning algorithm to predict the suitable fertilizer required for land-based on the analysis of soil nutrients through an advanced tool of data analysis outcome. The ML algorithm of HQ-CNN gives an accurate feature extracted from given input data and clustering the soil fertility for giving suggestions for best fertility suitable to the land using improved advanced technology. The HQ-CNN structure was used in this study has a multilayer structure consisting of an input layer, a hidden layer, and an output layer.

$$P_n = \sum_{i=1}^{m} w_{ij} x_i \qquad (1)$$

Typically, the advanced neural network of HQ-CNN is discussed in figure 2. The 'P' is defined as the input layer of the entire dataset from the soil nutrients of NPK. The number of input data is defined as 'n' and the weight (w) calculated for each interval of process and x is an input given in each process.

$$y_n = \varphi(P_n + b_n) \qquad (2)$$

Where y is an input signal, φ is an activation function of present layer values applied, b_n represents the bias is the activation function; and y_n is the output signal of theneuron.



Soil fertility is capable to supply soil and complement the nutrients, moisture, and air needed for plant development, but it changes occurs continuously along with the changes in environmental conditions. The dynamic changes of soil fertility analyzing time-consuming corresponding to the crop demand will be promising to investigate yields and high yields.

Types of Soil Fertility:

- Inherent or Natural Fertility
- Acquired Fertility

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The soil nutrients of N,P, and K are analyzed through the HQ-CNN algorithm of machine learning techniques to recommend soil fertility.

$$y_n = \varphi(H_n) \quad (5)$$

Where,
Y_n: the output signal of the neuron.
Φ: is the activation function of present layer values applied
H_n: Hidden layer of the neuron
The pattern layer consists of a set of active function

$$w_{ni} = b_n \quad (6)$$

The weight and bias, therefore, reformulated the model of the neuronthe effect of the bias is accounted for by doing two things: adding a new input signal fixed, and adding a new weight equal to the bias $b_k$different in appearance, they are mathematically equivalent.

$$H_n = \sum_{i=1}^{m} w_{ij} x_i + b_n \quad (7)$$

The proposed system recommending soil fertility through the feature of soil nutrients the attributes are nitrogen (N), phosphorus (P), and potassium (K) of input values are applied in the following equations.

E) DATA MINING OF SOIL FERTILITY

The data mining will produce the outcome attributes from the advanced machine learning algorithm of HQ-CNN. The fertility of recommended soil is clustering several attributes. In data mining, accurate soil fertility is detected using the HQ-CNN algorithm. The process is vice-versa until the needs of soil fertility attribute analysis.

$$\mu = \frac{1}{w_{IJ}} \sum_{i=1}^{m} x_i \quad (6)$$

$$\sigma = \sqrt{\frac{1}{w_{ij}} \sum_{i=0}^{m} (x_i - \mu)^2} \quad (7)$$

Where,
Q is an output layer in the training and testing dataset
μ, represent the outcome of input and hidden layers.

$$Q'_i = \frac{x_i - \mu}{\sigma} \quad (8)$$

The soil dataset is analyzed and depend upon the dataset of NPK attributes the HQ-CNN is applied in the proposed system. The Machine learning process of HQ-CNN techniques is used to cluster the soil fertility based on the soil nutrients. Using these techniques can analyze the quality of the recommended fertility. The advanced HQ-CNN techniques where gives high accuracy and best feature classification with data mining techniques.

IV. RESULT AND DISCUSSION

For evaluation propose loss measurement is declared as root relative square error (RRSE), Mean Bias Error (MBE), and statistical measures are noticed. RRSE compares the model prediction against the mean, which is frequently used to supply the soil nutrients value. An RRSE of less than 100% indicates a prediction that is better than the average value. Mean bias error (MBE) is the average estimation difference. Below Equation shows how these metrics are calculated, where y is the real yield value, y represents the soil nutrients attributes, is the average of the real yield values, and is the average of predicting soil fertility:

$$\text{RRSE } (\%) = \frac{\sqrt{(y-y*)\hat{}2}}{\sqrt{(y-y*)\hat{}2}} * 100 \quad (9)$$

$$MBE = \frac{\sum_{i}^{n} (y_i - y\wedge_i)}{n} \quad (10)$$

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Parameters	HQ-CNN Algorithm	Artificial Neural Network	Recurrent neural network
Sensitivity	91%	72%	81%
Specificity	89%	79%	76%
accuracy	99%	61%	73%

The statistical measures that can be considered some of the processes for evaluating the classification performances assume:

Accuracy (A)

$$A = \frac{TP+TN}{TP+FN+TN+FP} \quad (11)$$

Precision (P), or Positive Predictive Value (PPV)

$$P=\frac{TP}{TP+FP} \quad (12)$$

Recall (R), or True Positive Rate (TPR) or sensitivity

$$R=\frac{TP}{TP+FN} \quad (13)$$

Specificity (S) or else True Negative Rate (TNR)

$$S =\frac{TN}{TN+FP} \quad (14)$$

F-measure (F)

$$F=\frac{2P.R}{P+R} \quad (15)$$

A True Positive(TP) and False Negative (FN) of a specific classification of soil fertility through nutrients are considered by the classifier methods. The False Positive (FP) and True Negative (TN) are discussed as a worthy classification of neural values this is categorized has proper classification else incorrect classifier that specifies the false positive of the records.

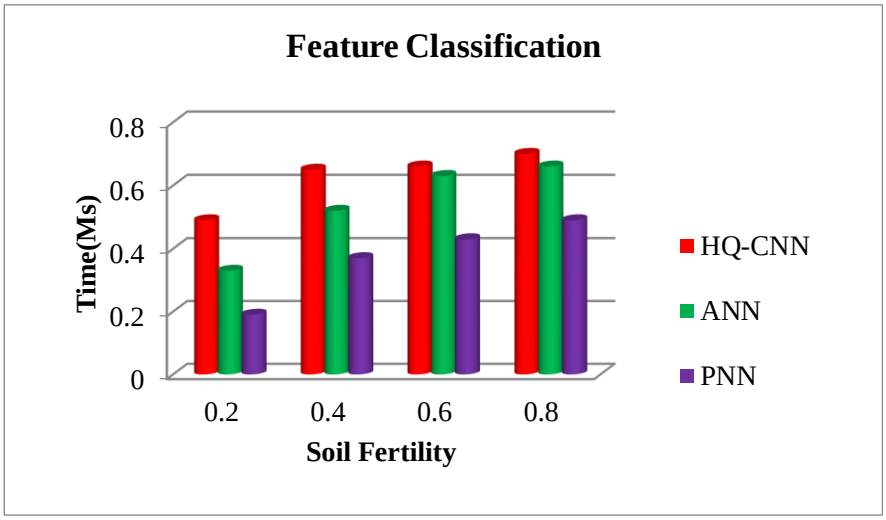

Figure 3: Accurate Classification of soil fertility

The below chart demonstrated the feature classification of soil fertility using the proposed algorithm of Hybrid Quantization Cascaded Neural Network (HQ-CNN) used to identify the suitable fertility depend upon the present nutrients of selected soil this is compared with existing algorithms.

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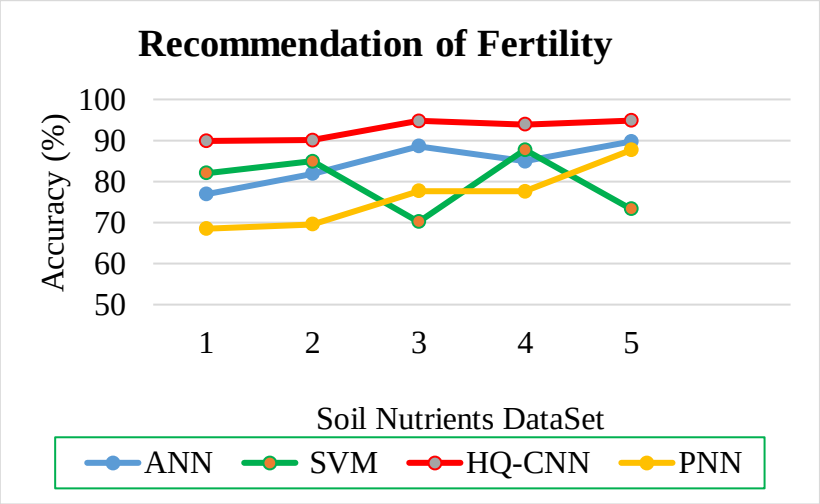

Figure 4: Accurate Recommendation of Soil Fertility

Figure 4 shows the accurate result of suitable soil fertility using proposed and existing algorithms. The above evaluation chart clarifiesthe high value of accurate diagnosis and cluster of soil fertility based on the soil nutrients present using proposed techniques of HQ-CNN compared with the existing algorithm ofANN, SVM, and PNN.

Time complexity

Compared with the HQ-CNN algorithm of the proposed method with SVM and PNN of the existing system the proposed machine learning algorithms are taken a minimum time for detecting diseases.

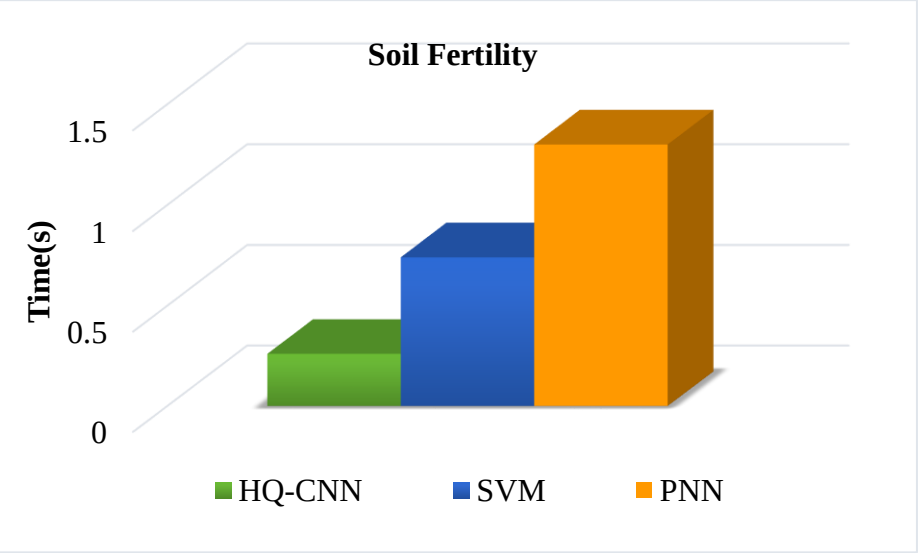

Figure 5: Comparison of Time complexity

Figure 5, required only a minimum number of times by the proposed methods. Hence, the proposed system classify the soil fertility from soil nutrients compared to existing methods SVM and PNN classifier. Therefore, the proposed system of HQ can provide low time complications than the existing methods.

V. CONCLUSION

Agriculture plays a primary role in many countries and this research concluded, the dataset of soil nutrients of NPK raw data is pre-processed. Thus this work would help farmers in sowing the right fertility based on soil nutrients to increase productivity and obtain profit. In this paper, we proposed classification algorithms HQ-CNN with data mining to generate an effective predictive model. The advanced machine learning process is used to provide suitable soil fertility. The mining classifies of suitable fertilizer classified by data mining techniques. Soil nutrients are nitrogen (N), phosphorus (P), and potassium (K) used are applied in the neural network of advanced machine learning algorithms by

applying equations of the HQ-CNN algorithm. The result illustrated the comparison of the statistical method gives a high accuracy rate compared with the existing system. The research shows that deep learning with data mining gives low time complexity, high accuracy, robustness, and good results of recommendingsoil fertility.

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