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Machine Learning Application in the field of Agriculture: A Review

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Abstract- Agriculture is the mainstay of a developing economy like India. Majority of its population depends on agriculture for their income. With depleting resources, reducing land sizes and increase in input and labor costs, combined with the uncertainty of various factors like weather, market prices etc, agriculture in India has become a profession which is full of risks. The advancements in technology must be worked upon across various disciplines and it has already shown dramatic improvements in many fields. However, agriculture has not benefitted much from such advancements. Smart farming is the need of the hour of the Indian economy. Machine learning is an imminent field of computer science which can be applied to the farming sector quite effectively. It can facilitate the up-gradation of conventional farming techniques in the most cost-friendly approach. The purpose of this paper is to broaden the farming horizon by listing and evaluating the different applications of machine learning in Indian agriculture and to help the farmers advance their work.
Terms: Machine Learning, Agriculture

1. INTRODUCTION

Agriculture is the backbone of every economy. In a country like India, which has ever increasing demand of food due to rising population, advances in agriculture sector are required to meet the needs. To add to it, the present economic conditions and government policies of India are such that it necessitates the adoption of Precision farming or smart farming. It will enable the farmers to maximize their crop yields and minimize the input costs as well as the losses due to reasons like uncertain rainfall, droughts etc. The agriculture sector needs a huge up-gradation in order to survive the changing conditions of Indian economy. Along with the advances in machines and technologies used in farming, useful and accurate information about different matters also plays a significant role in it. This information is being gathered by the use of remote sensors, satellite images, surveys etc. This information along with the knowledge of subject experts and researchers should be readily available to the farmers in order to exploit its potential worth. Also, as the amount of such information is increasing gradually, there is a dire need to analyze it to extract useful facts and patterns. This is where computer science and technology comes into the picture. Many algorithms have been proposed for this reason over time which has yielded good results. Machine learning (ML) has emerged together with big data technologies and high-performance computing to create new opportunities to unravel, quantify, and understand data intensive processes in agricultural operational environments.

2. OVERVIEW OF MACHINE LEARNING

Typically, ML methodologies involves a learning process with the objective to learn from "experience" (training data) to perform a task. Data in ML consists of a set of examples. Usually, an individual example is described by a set of attributes, also known as features or variables. A feature can be nominal (enumeration), binary (i.e., 0 or 1), ordinal (e.g., A+ or B-), or numeric (integer, real number, etc.). The performance of the ML model in a specific task is measured by a performance metric that is improved with experience over time. To calculate the performance of ML models and algorithms, various statistical and mathematical models are used. After the end of the learning process, the trained model can be used to classify, predict, or cluster new examples (testing data) using the experience obtained during the training process. Figure 1 shows a typical ML approach. metric that is improved with experience over time. To calculate the performance of ML models and algorithms, various statistical and mathematical models are used. After the end of the learning process, the trained model can be used to classify, predict, or cluster new examples (testing data) using the experience obtained during the training process. Figure 1 shows a typical machine learning approach.

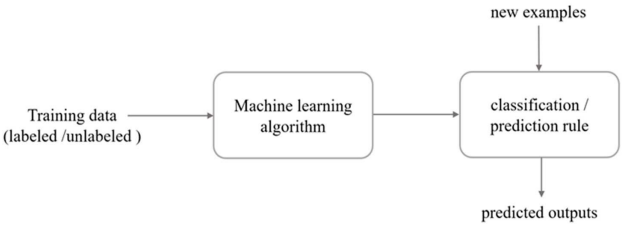

Figure 1. A typical machine learning approach

2.1. Types of machine learning

A. Supervised Learning

The algorithm is given some training examples on the basis of which it can study the inputs and their corresponding outputs. For example, showing a child the flag of a country and also telling him the name of

the country it belongs to. If the output variables are provided, the learning becomes supervised. Problems like classification and regression come under this category. Popular supervised learning algorithms are Artificial neural networks, Decision trees, K-means clustering, Support vector machines, Bayesian networks etc.

B. Unsupervised Learning

When the algorithm is not provided with any outputs, the learning is said to be unsupervised. For example, if we read a book in a language that we don‟t know, we don‟t understand anything, but we keep on reading or watching we will identify certain patterns in words slowly start understanding. Algorithms involving clustering techniques belong category. Popular unsupervised learning algorithms Self organized feature maps, COBWEB, DBSCAN etc.

C. Reinforcement Learning

This type of learning works on the principle of feedback. Every action has its impact on the system which is then reported back to the algorithm. The algorithm modifies its behavior according to the feedback received. Popular algorithms are Genetic algorithms, Markov decision algorithms etc.

3. APPLICATION OF MACHINE LEARNING IN AGRICULTURE

A Yield Prediction

Yield prediction, one of the most significant topics in precision agriculture, is of high importance for yield mapping, yield estimation, matching of crop supply with demand, and crop management to increase productivity. Examples of ML applications include in those in the works of [4]; an efficient, low-cost, and non-destructive method that automatically counted coffee fruits on a branch. The method calculates the coffee fruits in three categories: harvestable, not harvestable, and fruits with disregarded maturation stage. In addition, the method estimated the weight and the maturation percentage of the coffee fruits. The aim of this work was to provide information to coffee growers to optimize economic benefits and plan their agricultural work. In another study that used for yield prediction is that by the authors of [5], in which they developed a machine vision system for automating shaking and catching cherries during harvest. In another study [6], authors developed an early yield mapping system for the identification of immature green citrus in a citrus grove under outdoor conditions. The authors of [7] presented a method for the detection of tomatoes based on EM and remotely sensed red green blue (RGB) images, which were captured by an unmanned aerial vehicle (UAV).

B. Disease Detection

One of the most significant concerns in agriculture is pest and disease control in open-air (arable farming) and greenhouse conditions. In the literature [8], a tool is presented for the detection and discrimination of healthy Silybum marianum plants and those infected by smut fungus Microbotyum silybum during vegetative growth. In the work of [9], authors developed a new method based on image processing procedure for the classification of parasites and the automatic detection of thrips in strawberry greenhouse environment, for real-time control. Wheat is one of the most economically significant crops worldwide. The authors of [10] developed a new system for the detection of nitrogen stressed, and yellow rust infected and healthy winter wheat canopies based on hierarchical self-organizing classifier and hyperspectral reflectance imaging data. The study aimed at the accurate detection of these categories for a more effective usage of fungicides and fertilizers according to the plant's needs.

C Species Recognition

The last sub-category of crop category is the species recognition. The main goal is the automatic identification and classification of plant species in order to avoid the use of human experts, as well as to reduce the classification time. A method for the identification and classification of three legume species, namely, white beans, red beans, and soybean, via leaf vein patterns has been presented in [11]. Vein morphology carries accurate information about the properties of the leaf. It is an ideal tool for plant identification in comparison with color and shape

D Soil Management.

In Agriculture soil management is an important issue ML application on prediction-identification of agricultural soil properties, such as the estimation of soil drying, condition, temperature, and moisture content. Soil is a heterogeneous natural resource, with complex processes and mechanisms that are difficult to understand. In [12] the study presented a method for the evaluation of soil drying for agricultural planning. The method accurately evaluates the soil drying, with evapotranspiration and precipitation data, in a region located in Urbana, IL of the United States. The goal of this method was the provision of remote agricultural management decisions. In the second study [13] was developed for the prediction of soil condition. In particular, the study presented the comparison of four regression models for the prediction of soil organic carbon (OC), moisture content (MC), and total nitrogen (TN).

E Weather Forecasting

Indian agriculture mainly relies on seasonal rains for irrigation. Therefore, an accurate forecast of weather can reduce the enormous toil faced by farmers in India including crop selection, watering and harvesting. As the farmers have poor access to the Internet as a result of digital-divide, they have to rely on the little information available regarding weather reports. Up-to-date as well as accurate weather information is still not available as the weather changes dynamically over time. Researchers have been working on improving the accuracy of weather predictions by using a variety of algorithms. Artificial Neural networks have been adopted extensively for this purpose. Likewise, weather prediction based on machine learning

technique called Support Vector Machines had been proposed [3]. These algorithms have shown better results over the conventional algorithms and hence have a bright future for acceptance.

4. CONCLUSION

Now-a-days a growing number of applications of machine learning techniques in agriculture are required for which a large amount of data currently available from many resources can be analyzed to find the hidden knowledge. Machine learning is a naïve concept that can be very well implemented in any field which has complex relationships amongst the input and output variables. It has already established its prowess over conventional algorithms of computer science and statistics. Machine learning algorithms have enhanced the accuracy of artificial intelligence machines including sensor based systems used in precision farming. This paper has reviewed the various applications of machine learning in the farming sector.

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