IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 4, April 2016

Machine Learning: Applications in Indian Agriculture

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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 up by many notches.

Keywords: Indian Agriculture, Farming, Machine Learning, Applications.

I. 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.

II. MACHINE LEARNING AND ITS TECHNIQUES

Machine learning is the branch of computer science which is used to construct algorithms which exhibit self-learning property i.e. learning which is done by the machine itself hence the term 'Machine Learning'. It is considered to be one of the major areas under Artificial Intelligence. For a machine to become intelligent like a human mind, it has to first think and learn like a human. Human mind learns from past data and experiences that it is exposed to and based on that it takes decisions in future. Any conventional computer algorithm works as it is programmed by its developer. In other words, it will only follow the instructions given by its controller. For a machine to exhibit intelligence, it has to interpret and analyze the input and result data apart from simply following the instructions on that data. This is what the machine learning algorithms do.

These algorithms can build the system model from the input and output data. The system can then be used to predict future values. These methods are far better than the conventional statistical methods as they do not rely on the user-specified parameters rather self improvise using the available data. The applications of machine learning are multi-disciplinary where traditional rule-based algorithms are not possible to be constructed or fail to deliver correct results. One such field is agriculture. There are three types of learning and algorithms in 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

IJARCCE

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International Journal of Advanced Research in Computer and Communication Engineering
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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.

III.APPLICATIONS IN AGRICULTURE

The various applications of machine learning techniques in agriculture have been listed in this section. These techniques will enhance the productivity of fields along with a reduction in the input efforts of the farmers.

A. Crop Selection and Crop Yield Prediction

To maximize the crop yield, selection of the appropriate crop that will be sown plays a vital role. It depends on various factors like the type of soil and its composition, climate, geography of the region, crop yield, market prices etc. Machine learning provides many effective algorithms which can identify the input and output relationship in crop selection and yield prediction. Techniques like Artificial neural networks, K-nearest neighbors and Decision Trees have carved a niche for themselves in the context of crop selection which is based on various factors. Crop selection based on the effect of natural calamities like famines has been done by Washington et al [1] based on machine learning. The use of artificial neural networks to choose the crops based on soil and climate has been shown by researchers [2]. A plant nutrient management system has been proposed based on machine learning methods to meet the needs of soil and maintain its fertility levels and hence improve the crop yield [3]. A crop selection method called CSM has been proposed [4] which helps in crop selection based on its yield prediction and other factors.

B. 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 [5]. These algorithms have shown better results over the conventional algorithms and hence have a bright future for acceptance.

C. Smart Irrigation System

Farming sector consumes a huge portion of water in India. The levels of ground water are dropping day-by-day and global warming has resulted in climate changes. The river water for irrigation is a big issue of dispute among many states in India. To combat the scarcity of water, many companies have come up with sensor based technology for smart farming which uses sensors to monitor the water level, nutrient content, weather forecast reports and soil temperature. EDYN Garden sensor is another example [6]. However, the high cost of such devices deters the small land owners and farmers in India to use them. These smart devices are being designed on the principles of machine learning, working with the sensors' data and improving the system over time all by itself. The nutrient content of soil can also be recorded using the sensors and hence used for supplying fertilizers to the soil using smart irrigation systems. This will also reduce the labor cost in the fields, which is a huge crisis being faced by the Indian farmers these days.

D. Crop Disease Prediction

Machine learning methods have been used in the recent years for crop disease prediction and these efforts have been proved worthwhile. They revealed higher accuracy compared to the traditional statistical methods like regression analysis. These methods deal well with noisy and multi-faceted data [7][8][9]. Early crop disease detection and classification has been done using Support Vector Machines [10]. There are several factors like soil quality, crop rotation cycle, seed quality etc which can lead to poor health and diseases in crops. Machine learning algorithms effectively take into consideration all the possible factors, historic data as well as satellite/sensor data of fields to provide valuable disease classifiers. Disease detection using images of crop leaves has been implemented using pattern recognition branch of machine learning. It works by obtaining patterns from input data and separating them into classes of diseases [11].

E. Deciding the Minimum Support Price

Another important aspect of agriculture is the Minimum Support Price (MSP) of different crops announced by the government. MSP is an assurance to the farmers from the government that their crop will not fall below this price. The government also uses it to promote the sowing of particular crops which have greater demand but less supply. This price is decided on the recommendations of Commission for Agricultural Costs and Prices (CACP) which in turn takes into account various factors like cost of production of crop, changes in input costs, demand and supply, market prices trends, inter-crop price parity etc as well as certain costs which depend on the area where crops are cultivated, e.g. cultivation costs in a particular area, transportation, marketing costs etc [12]. Such enormous amount of data has to be analyzed by the Commission before deciding the MSP for the season. Machine learning algorithms are appropriate for this purpose. They provide means for comprehensive analysis of such data which is quite complex and where conventional algorithms fail to produce results.

DOI 10.17148/IJARCCE.2016.5487

The crux of all these applications is given in the Table I below. It summarizes all the points in brief.

TABLE I Applications of Machine Learning in Agriculture

S. No.	Machine Learning Applications in Agriculture		
	Field of Study	**Author**	**Algorithms Used**
1	Crop selection and Crop yield prediction	Washington et al	Classification algorithms
		Snehal et al	Neural Networks
		Shivnath et al	Back propagation neural networks
		Rakesh et al	CSM
2	Weather Forecasting	Y. Radhika et al	Support Vector Machines
3	Smart Irrigation System	Aditya Gupta et al	General Machine learning algorithms
4	Crop disease prediction	Rumpf et al	Support Vector Machines
		M.P. Raj et al	Pattern Recognition
		Mehra et al	Artificial neural networks, Regression trees, Random forests
5	Deciding the MSP	Suggested by author	Classification techniques, Neural networks etc. may be used

IV. CONCLUSION

Agriculture is a field that has been lacking the mass adoption of technology and its advancements. Indian farmers need to be up to the mark with the international techniques. 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. It also provides an insight into the troubles faced by Indian farmers and how they can be resolved using these techniques.

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BIOGRAPHY

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