Data Mining Application and Limitation in Agriculture

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Abstract ;-Agriculture is the main occupation and backbone of our country. Data mining is emerging as one of the important field in agriculture. Data mining helps in predicting different parameters that are affecting the agriculture like rainfall , yield, temperature , fertilizers , pesticides , and different environment and atmospheric . This paper will present different application and limitation of data mining in the field agriculture.

Keyword:-Data mining , clustering algorithm , naive Bayesian classification , Support vector machine, Support Vector Machine (SVM).

Data Mining in Agriculture

Data mining techniques have already been successfully applied in various fields including engineering, medicine, education, marketing etc. In agriculture, farmers have many queries regarding the kind of soil and climatic conditions for cultivation of a specific crop and the timelines corresponding with each activity related to agriculture. Recently, a number of studies have been carried out on the application of data mining techniques for agricultural data sets.

Application of data mining in agriculture

1. Classification of soils and prediction of soil fertility

The improved clustering algorithm is a good method for comprehensive evaluation of soil fertility. The k-means algorithm is used for soil classifications using GPS-based technologies [27], classification of plant, soil and residue regions of interest by color images [28]. Decision tree approach technique is also used in the prediction of soil fertility [29]. In addition, naive Bayesian classification technique is used to classify soils that analyze large soil profile experimental datasets [30]. A range of spectral reflectance patterns in the visible and infrared range were examined by deploying remote sensing for detection of plant stress, particularly nutrient deficiency [31]. This approach can potentially lower operating cost of fertilization and may minimize loss of crop productivity.

2. Relationship between sprays and fruit defects

Fruit defects are caused for a multitude of reasons including physical injury or the damage caused by birds, pathogens and insects. These defects may be recorded manually or through computer vision (detecting surface defects when grading fruit). Spray diaries are a legal requirement in many countries and record the date of spray and the product name. It is known that spraying affects different fruit defects for different fruits. Fungicidal sprays are often used to prevent rots from being expressed on fruit. It is also known that some sprays can cause russeting on apples. Grading of apples is done before marketing using k-means clustering [32]. Currently some efforts have been made with regard to the use of data mining in horticulture [33].

3. Forcasting of weather and rainfall

For simulation of daily precipitations and other weather variables, k-nearest neighbor approach technique can be applied [34]. It also helps in the forecasting of climate and in the estimation of soil water parameters which are referred to as lower limit of plant water availability (LL), drained upper limit (DUL) and plant extractable soil water (PEWS) [35]. With the advancement of satellite remote sensing technologies, the forest and agricultural land observations have become very convenient. These sensors produce potentially useful data in enormous quantity on daily basis. This quantity of data also presents a challenge of data interpretation and classification to the researchers. Scientists have been widely using techniques such as k-means, k-nearest neighbour and artificial neural network for classification of remotely sensed images. Somvanshi et al. [36] designed the model for the prediction of rainfall using artificial neural networks and Box-Jenkins methodology. Other applications of artificial neural networks in hydrology are forecasting daily water hassle and flow forecasting. Sawaitul et al. [37] focused the information about weather and the recorded parameters were used to forecast weather. If there is a change in any one of the recorded parameters like wind speed, wind direction, temperature, rainfall and humidity, then the upcoming climatic conditions can be predicted using artificial neural networks and back propagation techniques. Farmers are being issued information from the state agricultural universities and government kissan portals through e-mails or SMS about the weather conditions, sowing of crops and prevalence/prevention of pathogens and pests in different geographical regions and agro-ecosystems.

4. Prediction of crop yield

For estimation and analysis of the crop yield, k-means clustering is used [38]. Jagielska et al. [39] described applications of data mining to agricultural related areas in relation to yield prediction. In the past, yield

prediction was achieved by considering farmer's experience on particular field, crop and climate condition. The additional information about data like probability in probability theory, grade of membership in fuzzy set theory could also be discussed. The neural network is used in prediction of flowering and maturity dates of soybean [40] and in forecasting of water resources variables [41]. Veenadhari [42] studied the influence of climatic factors on major kharif and rabi crops production in Bhopal district of Madhya Pradesh state. The findings showed that the productivity of soybean crop was mostly influenced by comparative humidity followed by temperature and rainfall by using the decision tree analysis technique. The same technique showed that the productivity of paddy crop was mostly inclined by rainfall followed by comparative evaporation and humidity. For wheat crop, the analysis revealed that the productivity is mostly influenced by temperature followed by relative humidity and rainfall. The result of decision tree was confirmed from Bayesian classification. The rules formed from the decision tree were useful for identifying the conditions required for high crop productivity.

5. Planning of grain, oil seed or cash crops for cultivation

Genetic algorithms can be used for the process of decision making with the purpose of finding appropriate crops to grow, which will be highly profitable to our farmers [43]. Support vector machine technique may be used in area of the crop classification [44] and in the analysis of the climate change scenarios [45]. It can also be used for detecting weed and nitrogen stress in corn [46].

6. Control of weeds among the crop plants in the field

Weeds are unwanted useless plants that compete with crop plants for space, nutrients, water, sunlight and other elements. These weed plants reduce the biomass and yield of the main crop. Thus, weeds pose a serious constraint to agricultural production and usually result in average ~ 12% losses of the world s agricultural output. Therefore, weed control is indispensable in every crop production system. The losses due to weed growth include interference with cultivation of crops, loss of biodiversity, loss of potentially productive lands, loss of grazing areas and livestock production, choking of navigational and irrigation canals and reduction of available water in water bodies. They decrease quantity and quality of produce/food, fibre, oil, forage/fodder and animal products (meat and milk), and cause health hazards to humans and animals. Weeds force the use of large amounts of human labour and technology to prevent greater crop losses.

Goel et al. [47] reported a strong correlation between the digital information, e.g., spectral data of the aerial image and soybean crop physiological parameters such as chlorophyll fluorescence, leaf greenness, leaf area index, photosynthesis rate and plant height. They used multi-spectral (24 wave band with a range of

475.12 nm to 910.01 nm) airborne optical remote sensing technique for detecting weed infestation in site-specific managed field crops. Their results indicated that the wave band centered on 675.98 and 685.17 nm in the red region and 743.93 to 830.43 nm in the NIR region, had good potential for weed classification in a maize field. The Schiffes multiple range tests provided a p-value that was less than 0.05 to support their findings. Tellaeche et al. [48] purposed an approach for the detection of weeds in agriculture and summarized an automatic computer vision system for the detection and differential spraying of Avena sterilis, a toxic weed found in cereal crops. So, a hybrid decision making system based on the Bayesian and Fuzzy k-means classifiers has been designed where the apriori probability required by the Bayes framework is supplied by the Fuzzy k-means.

7. Optimizing the use of pesticide by data mining

Global crop yields are reduced by 20 to 40% annually due to attack of plant pests and pathogens. For the control of pests and phytopathogens in agriculture, farmers have mostly relied on the application of synthetic pesticides and the global pesticide market is presently growing at a rate of 3.6% per year [49]. However, indiscriminate use of chemical pesticides to control the pathogens/insects has generated several problems including resistance to insecticides/fungicides, outbreak of secondary pests as well as safety risks for humans and domestic animals. Moreover, the long persistence of applied pesticides in soil leads to contamination of ground water and soil, and the residual toxic chemicals may enter in the food chain. Hence, excessive use of pesticides is harming the farmers with adverse financial, environmental and social impacts. Recent studies showed that attempts of cotton crop yield maximization through pro-pesticide state policies have led to a dangerously high pesticide use. Coarse estimates of the cotton pest scouting data recorded stands at around 1.5 million records and growing. The primary agro-met data recorded has never been digitized, integrated or standardized to give a complete picture and hence, cannot support decision making. These studies have reported a negative correlation between pesticide use and crop yield. By data mining, using the cotton pest scouting data along with the meteorological recordings, it was shown that how pesticide use can be optimized (reduced). Clustering of data revealed interesting patterns of farmer practices along with pesticide use dynamics and hence help in identifying the reasons for this pesticide abuse [50]. Creating a novel Pilot Agriculture Extension Data Warehouse followed by analysis through querying and data mining some interesting discoveries were made, such as pesticides sprayed at the wrong time, wrong pesticides used for the right reasons and temporal relationship between pesticide usage and day of the week [51].

8. Sorting apples by water cores

Before going to market, apples are checked and the apples showing some defects are removed. However, there are also invisible defects that can spoil the apple flavor and look. An example of invisible defect is the watercore. This is an internal apple disorder that can affect the longevity of the fruit. Apples with slight or mild watercores are sweeter, but apples with moderate to severe degree of watercore cannot be stored for any length of time. Moreover, a few fruits with severe watercore could spoil a whole batch of apples. For this reason, a computational system is under study which takes X-ray photographs of the fruit while they run on conveyor belts [52] and which is also able to analyse (by data mining techniques) the taken pictures and estimate the probability that the fruit contains watercores [53]. Neural network is also applied for discrimination between good and bad apples.

9. Prediction of problematic wine fermentations

Wine is widely produced from grapes all around the world. The fermentation process of the wine is very important, because it can impact the productivity of wine-related industries and also the quality of wine. If the fermentation defect could be categorized and predicted at the early stages of the process, it could be altered in order to guarantee a regular and smooth fermentation. Fermentations are nowadays studied by using different techniques such as the k-means algorithm [54] and a technique for classification based on the concept of bi-clustering [55]. Urtubia et al. [56] demonstrated that the prediction of wine fermentation problems can be performed by using a k-means approach. Knowing in advance that the wine fermentation process could get jammed or be slowed, it can help the enologist to correct it and ensure a good fermentation process. Moreover, taste sensors are used to obtain data from the fermentation process to be classified using ANNs [57].

10. Prediction of metabolizable energy of poultry feed using group method of data handling-type neural network

A group method of data handling-type neural network (GMDH-type network) with an evolutionary method of genetic algorithm was used to predict the metabolizable energy of feather meal and poultry meal based on their protein, fat and ash content [58]. Published data samples were used to train a GMDH-type network model. It is also reported that the GMDH-type network may be used to accurately estimate the poultry performance from their dietary nutrients such as dietary metabolizable energy, protein and amino acids [59].

11. Detection of diseases from sounds issued by animals by neural networks

The detection of animal s diseases in farms can impact positively the productivity of the farm, because sick animals can cause contaminations. Moreover, the early detection of the diseases can allow the farmer to cure the animal as soon as the disease appears. Coughing, in human and animals, is associated with the sudden expulsion of air and it is typically accompanied with a sound, whose changes may reflect the presence of diseases. The sound provided by pigs due to coughing can be used to monitor possible health problems. An expert could analyze whether the cough of a pig signals the presence of a potential disease and eventually check the health of the pig. Systems for the automatic control of the pig houses are useful to avoid the infection of humans because of the presence of contagious diseases. Therefore, considerable efforts have been undertaken to develop and apply sensing techniques for diagnosis of diseases in pig farms. The early detection of animal diseases can bring on the consumer s table better meat, by reducing, for instance, the residuals of antibiotics. A neural network approach for cough recognition is described [60]. The training set is obtained by experimental observations, where the sounds produced by pigs are recorded and where each record is labeled by an expert in different ways. A metal construction has been built in order to perform the experiments, where pig sounds are recorded. The construction is covered with transparent plastic material for controlling the environment around the animal. The time signal of these sounds is analyzed mathematically and transformed in a vector formed by 64 real numbers. The vectors are normalized before the use, because their components can variate significantly even when comparing two vectors from the same class. These variations are mainly due to the distance and direction between the pigs and the microphone. A neural network is trained using the training set obtained during the experiments. The used network is a multilayer perceptron with one hidden layer of hyperbolic tangent neurons, while the output layer consists of logistic neurons. The network is firstly trained to discriminate between coughs and metal clanging, and it is able to reach percentages of correct recognition greater than 90%. Successively, the network is trained in order to distinguish among four sounds: coughs, metal clanging, grunting and background noise.

12. Growth of sheep from genes polymorphism using artificial intelligence

Polymerase chain reaction-single strand conformation polymorphism (PCR-SSCP) method was used to determine the growth hormone (GH), leptin, calpain and calpastatin polymorphism in Iranian Baluchi male sheep. An artificial neural network (ANN) model was developed to describe average daily gain (ADG) in lambs from input parameters of GH, leptin, calpain and calpastatin polymorphism, birth weight and birth type. The results revealed that the ANN-model is an appropriate tool to recognize the patterns of data to predict lamb growth in terms of ADG given specific genes polymorphism, birth weight, and birth type. The platform of PCR-SSCP approach and ANN-based model analyses may be used in molecular marker-assisted selection and breeding programs to design a scheme in enhancing the efficacy of sheep production [61].

Issues of Data Mining in Agriculture

There are still some challenges in data mining application that need to be overcome.

1.More generalization

Data mining or data mining techniques is not specified for the particular field or data. They are applicable for the any type of data in any field. However, when algorithms applied to various type of databases such as transactional database, data warehouse are differed from each situation [5].

2. Require special Knowledge

1. Another major issue that attached with the data mining is the results which obtained the applications are need to special knowledge or experience for identify and utilized the given data volume [15].

2. At present most of the existing approaches are used the k-means and other basic approaches for provide the solutions. Because most of the researchers and expertise in computer science and agricultural field have only basic knowledge.

Also, some complex data mining techniques such as biclustering technique still have not been used to address the agricultural problem. As well as approach of parallel computing have not been used to agricultural application. Parallel computing is a technique which consumes less time period to perform the tasks [3].

The results of these prediction mechanism are more complex. Therefore, need expert knowledge or expert person to understand and analyze those results [14].

3. Test against small size of data

Most of the existing systems considered only part of the dataset or small size of dataset to determine the result. It is limiting the efficiency of crop yield prediction. Therefore, there is a vacancy for approaches which are increasing the efficiency of crop yield prediction by considering the entire data set [18].

4. High Computational Cost

1. Another issue is to address the agricultural problems presents set of the data mining techniques such as clustering and classification, k-Nearest Neighbor, k-Means. Problem of k-Means algorithm is there can be choice of various parameter ‘k’. Also, it takes cost of computational [12].

2. The WEKA system has not supported to handle multiple algorithms at a same time. It needs more times and high computational cost [13].

5. Limited resources

In India, most of the farmers have small area of land. It is difficult to use applications, machines produced for large agricultural field. Less coverage of the Internet limit the usage of IT application. Less availability of the infrastructure facilities [2].

Applications of Data Mining

Data mining techniques and systems have been used in agricultural field by addressing the various problems in diverse fields such as soil characterizing, diseases identification, identify demand in a market.

Neural network has been used to weather forecasting. The system is developed to record the parameters which are relevant to weather situation such as speed and direction of the wind, temperature and humidity of area, rainfall size and time range. If there were any change in those parameters, can be predict the upcoming weather situation by using Neural network. Prediction can be done for the large area by increasing the result of small area [4]. Also, a system to identify the bad apples from good apples and a system to classify the eggs have been developed by using neural network [12]. Another Artificial neural network's application is a system to find the relationship between yield measurements and limiting factors [24].

Pakistan researchers was built the system to check whether the usage of pesticide is maximized the yield prediction. In this system data perform through the unsupervised clustering. As the result system gave negative relationship between yield prediction and pesticide usage. when the usage of pesticide is increased it was harmful for farmers in financially, healthy and environmentally [6].

Helps of the Support Vector Machine (SVM) technique developed a system to recognize the sounds of birds, a system to classify the spread of source on pizza, a system to measure the nitrogen pressure in corn and a system to classify the crops [12].

k-means approach is used to build a system to solve the fermentation problem which could be slow or get stuck when occurred the wine making process [20]. Also, k-means approach is applied to identify the unknown parameters related to water in soil. That parameters includes clay, carbon, other organic characteristic and textures. k-mean approach used to identify soil parameters by identifying the similar textures [3].

An automated system to improve the process of soil classification was developed. Fertility of the soil sample is the key point of that system. According to fertility, soil samples labeled as very Low, Low, Moderate, Moderately High, High, Very High. The system helps to label the soil samples. For further comparative study, use classification algorithms [25].

Applications of Naive Bayes classifier such as Unified Soil Classification System (USCS), AASHTO Soil Classification System and the Modified Burmister, French Soil Reference System are used to soil classification process in different countries. There are three main classification groups in USCS like Highly organic soils, Fine-grained soils, Coarse-grained soils [21].

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