A Review of Fuzzy Rule Promotion Techniques in Agriculture Information System

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ABSTRACT
Integration of soft computing techniques in the development of agricultural expert information systems, decision support systems etc. to predict the response of the agricultural output parameters with reference to the input information to the system has helped a lot of farm stakeholders where the expertise is not available. One of the soft computing techniques is fuzzy logic. This paper provides the review of the fuzzy rule promotion methodology as applied to oilseeds diseases diagnosis system. The methodology of the system has been discussed and drawbacks in the web based intelligent diseases diagnosis system and the rule promotion methodology has also been presented.

Keywords
Agricultural information system, fuzzy logic, rule promotion methodology, expert systems, disease diagnosis.

1. INTRODUCTION
Indian economy is based mainly on agriculture produces. According to Census of India, 2011, almost 68.85% of the population lives in the rural areas and most of them are involved in the agricultural and related activities. A large amount of work has been done on increasing the quality and quantity of agricultural produce. It is also very important that the technology thrust should lay greater emphasis on the dissemination of scientific and technological information from the laboratory and test fields to its actual stakeholders. Print and electronic media like libraries and information centres (like Kisan Call Centres) are playing a very important role in providing information to the farmers. These information centres are basically providing information to the users using information systems. An information system (IS) is uses information technology to support various operations and management of people's activities. In a very broad sense, the term IS is frequently used to refer to the interaction between people, algorithmic processes, data and technology [1]. It also refers to the way in which people interact with this technology in support of a collection of related, structured activities or tasks that produce a specific service or product or serve a particular goal for a particular customer or customers called a business process or business method. It often can be visualized with a flowchart as a sequence of activities to achieve a particular product or service.This paper is organized into four different sections. Section-1 introduces the topic. Review of ICT in agriculture has been presented in section-2. Section-3 describes the soft computing techniques and agricultural information systems (AIS). This section also describes the fuzzy rule promotion methodology in AIS. A discussion has been recorded in the section-4 and section-5 describes the conclusion and future scope of Work..

2. ICT AND AGRICULTURE
Information Communication Technology (ICT) is all kinds of technologies that enable users to create, access and manipulate information. ICT is a combination of IT and communications technology [2]. It stresses the role of unified communications and the integration of telecommunications, intelligent management systems and audio-visual systems in modern era of information technology. ICT consists of all technical means used to handle information and aid communication, including computer and network hardware, communication middleware as well as necessary software. In India, direct application of computerized information systems to the farmers is very difficult in the present conditions because of various application constraints. The application of ICT in agriculture is increasingly important. E-Agriculture [3] is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. It involves the conceptualisation, design, development, evaluation and application of innovative ways to use ICT in the rural domain, with a primary focus on agriculture. E-Agriculture is a relatively new term and it is expected that its scope to change and evolve as the understanding of the area grows. The IT applications are very prominent in the field of agricultural and veterinary sciences. The area may be the soil and water engineering, soil characteristics, irrigation and fertilization, precision agriculture including the farm machinery equipment, pest management, post harvest engineering aspects that include processing and food engineering, shipping management of the food products etc, management of farm flora and fauna.

3. SOFT COMPUTING AND AIS
Soft computing is a set of computing techniques, such as Fuzzy Logic (FL), Artificial Neural Networks (ANNs), and Genetic Algorithms (GAs). These computing techniques, unlike hard computing, which refers to a huge set of conventional techniques such as stochastic and statistical methods, offer some what "inexact" solutions of very complex problems through modelling and analysis with a tolerance of imprecision, uncertainty, partial truth, and approximation. In effect, soft computing is an integration of biological structures and computing techniques. Soft computing is used to achieve tractability, robustness, and provide a low cost solution with a tolerance of imprecision, uncertainty, partial truth, and approximation. This makes soft computing capable of solving problems that more conventional methods have not yet been

able to provide in a cost-effective, analytical, or complete manner. ANNs are mathematical model or computational model that provides configurations made up of interconnecting artificial neurons that mimic the properties of biological neurons. In agriculture application of ANN is prominent. [4] used image analysis and artificial neural network to predict mass transfer kinetics and color changes of osmotically dehydrated kiwifruit slices. [5] explores evaporation estimation methods based on ANN and adaptive neuro-fuzzy inference system (ANFIS) techniques.GAs are a way of solving problems by mimicking the same processes nature uses through selection, recombination and mutation. Local wind climate [6] and precision agriculture application of sensor networks [7] etc. are the area where the application of GA has been made. FL develops multi-valued, non-numeric linguistic variables for modeling human reasoning in an imprecise environment.Among soft computing techniques, FL appears to be the first one that has established fundamental ideas of soft computing. Fuzzy logic is all about the relative importance of precision: How important is it to be exactly right when a rough answer will do? L. A. Zadeh, a professor at the University of California at Berkeley, was the first to propose a theory of fuzzy sets and an associated logic, namely fuzzy logic [8]. Essentially, a fuzzy set is a set whose members may have degrees of membership between 0 and 1, as opposed to classical sets where each element must have either 0 or 1 as the membership degree. If 0, the element is completely outside the set; if 1, the element is completely in the set. As classical logic is based on classical set theory, fuzzy logic is based on fuzzy set theory. L. A. Zadeh, once remarked: 'In almost every case you can build the same product without fuzzy logic, but fuzzy is faster and cheaper' [9]. Fuzzy logic is based on natural language. The basis for fuzzy logic is the basis for human communication. This observation underpins many of the other statements about fuzzy logic. In 'two-valued logic', a proposition is either true or false, but not both. The 'truth' or 'falsity', which is assigned to a statement, is its truth-value. In fuzzy logic a proposition may be true or false or have an intermediate truth-value, such as maybe true [10]. The established basic ideas have influenced other techniques that arrived later. The Parallel Distributed Processing (PDP) research group published a series of results and algorithms [11]. This work gave a strong impetus to the study of mechanisms and structure of the brain and provided the catalyst for much of the subsequent research and application of ANNs. This can be viewed as the point at which ANNs became one of the soft computing techniques. Currently, FL, ANNs, and GAs are considered as core techniques of soft computing. The current list of soft computing techniques also includes machine learning, probabilistic reasoning, and chaos theory. A lot of information systems, expert systems, and decision support systems has been developed using then FL in various area of agriculture may it be crop cultivation, water and soil management, application of fertilizer, pest management, harvesting, post harvest handling, transporting of food/ food products packaging, food preservation, food processing, value addition, food quality management, food safety, food storage or food marketing etc. Many diagnostic expert systems have been developed in the last three years by applying the fuzzy logic in the area of agriculture and allied fields. FL have been applied to the crop land suitability [12], operation of biogas reactors running on energy crops [13], automated irrigation systems [14], the management of yield behaviour of cotton using fuzzy cognitive maps [15], understanding the way the ecological and social components interact in a settlement (a village, town, city) is the key to manage effectively the coupled human–natural system and start programs for its sustainability [16], assessing soil condition in agro-eco systems [17], nutrient management decision- making for rice crop planning [18], land-slide hazard mapping [19], automatic adjustment and control of the harvester to achieve minimal grain losses especially at the position of straw walker and upper sieve [20], land reallocation studies [21], soil productivity sustainability [22], classification and control of lameness and mastitis in cows [23], to explore the extensive assessment of uncertainties in different management aspects of environmental system [24]. The Mamdani fuzzy inference system (MFIS) was used to classify the productive trees based on yield, fruit length and visual appearance, and to produce a tree total quality map for each grove [25]. An exploratory study had been made in applying wireless sensor networks and fuzzy control technology, which builds a water-saving irrigation system [26]. The post adjustment of input data from a remote source to fit localized weed prediction for the control and management of weed infestation has been explored [27]. A fuzzy reasoning method introducing Euclidean distance method to calculate the comparability; effective diagnosis results and reliabilities to fulfil the complexity of agriculture disease problem, is presented in agriculture disease diagnosis expert system [28]. Most of the expert systems have a static knowledge base with static reasoning and inference techniques. Therefore, the decision-taking power of these conventional systems remains same throughout the life of the system unless the knowledge engineer modifies the system explicitly. The available systems also need further improvements. [29] described the development of a web-based intelligent disease diagnosis system (WIDDS). WIDDS is a web based information system, which provides the access to the disease information at large for oilseeds crops, soybean, groundnut and rapeseed mustard. The system provides an intelligent support to improve the decision-making ability of farmers/cultivators, agriculture advisors/ extension workers, researchers, managers, policy makers etc. It is using a new fuzzy logic approach of rule promotion approach. This approach enables the drawing of inferences with the enhanced intelligence. According to this approach, the rules of a particular disease are promoted and demoted as and when a session is completed for the diagnosis of particular disease. With each session the weight factor changes as the frequency of the rule firing changes. The promotion factor of the rule changes every time as the product of the frequency of firing of the rule and the weight factor thus obtained after every session. This rule-promotion factor is used to increase the existing rule confidence using the following fuzzy logic algebra. Let the existing rule confidence factor of a rule a rule is say CF.

$$PCF = CF + PF - CF \times PF \quad (1)$$

Where PCF is the new promoted confidence factor, PF is the current promotion factor of the rule.

With this logic PCF is always less than or equal to one, whereas PCF = 1 represents full confidence and PCF = 0 represents no confidence in the rule. Hence it can be said that the rule for which the expert's confidence factor is one that rule will neither be promoted or demoted. It remains unaffected whether the rule is fired or not in successful or non-successful sessions. So, the confidence in the all other rules is promoted by assigning it a

new confidence factor that is promoted confidence factor and all the future disease diagnosis decisions are based on this improved confidence PCF for all the rules stored in the dynamic knowledge base.

4. DISCUSSION

During our discussion about the rule promotion methodology it has been found that if there is an error in the estimation of the confidence factor of the rule then that error will vary at a linear pace, as the error may be due to the variation in the CF defined by different experts. The WIDDS system provides no information about the infected geographical area. In some cases we are not able to guess the exact location of the activity under review. A repetition of the activity in the developed system may not be able to guess the geographical area of the activity and hence unable to deliver about the activity in the specific geographical area of interest. As the most of the systems are standalone systems. These systems can be either used in laboratory or by the subject matter experts in the field on their laptops. It may require the Internet connection and the knowledge of the computer is the basic requirement for a farmer to use these kinds of systems. There is possibility that there is non-availability of computer/ laptops/ Internet, extension/research worker in the farm field. The farmer may not have the access for these things.

5. CONCLUSION AND FUTURE WORK

There is a need of further modification in the rule promotion methodology by minimizing the errors in the estimation of confidence factor and then estimation of the promoted confidence factor of the rule. Secondly in the present scenario where there is non-availability of Internet, non-conversance of the farm community with internet/computer, the information systems based on the basic mobile systems should be developed, which are cheap and may be available to the most of the farm community everywhere. In future the work can be carried out in this direction.

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