A Survey on Usage of Soft Computing Techniques in Crop Production

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Abstract

In India, Agriculture sector faces many problems in enhancing production with available natural resources. Soft computing techniques shows great ability in solving problems like crop selection, crop planning, irrigation planning, water resources management, vegetable production, water resource management etc has been discussed in the present paper. In 1st phase focus has been made on soft computing and its components. In 2nd phase different techniques which have been used in improving crop production based on soft computing with merits and demerits are discussed. Survey table is prepared after doing literature survey on existing work on soft computing which is useful in understanding problems and corresponding problem solving technique which gives a better way to crop production and precision agriculture.

Keywords: *Soft computing, technique, resource management, precision agriculture, crop production.*

I. INTRODUCTION

India is an agricultural country and majority of its population is engaged in agricultural works and farming outcomes being their own source of income. Infact,on one side agriculture provides food security to the people and on other hand it provides raw materials to agro-based industries. Agriculture sector in India faces many challenges of enhancing production with available natural resources. ICT plays important role in addressing these challenges [1] .Usage of soft computing techniques in field study saves human labor .Field study plays a vital role in economic importance of agriculture which in turns result in poverty reduction [2].Soft computing is a set of "inexact" computing techniques which are able to model analyze very complex problems[3]

The main components of soft computing are fuzzy logic, artificial neural network, genetic algorithm have shown great ability in solving problems in agricultural system such as crop selection, crop planning, irrigation planning, water resources management, vegetable production, water resource management [4]etc.

A. Fuzzy Logic

FL is a form of multi-valued logic derived from fuzzy set theory to deal with reasoning that is approximate, rather than precise. In contrast to yes/no or 0/1 binary logic (crisp), FL provides a set of membership values inclusively between 0 and 1 to indicate the degree of truth (fuzzy)[3]

Fuzzy Inference

Fuzzy inference system is a scientific tool permitting simulation of a system without a detailed mathematical description. There are two common types of inference method, including Mamdani and Sugeno. Mamdani is the most commonly seen fuzzy methodology that basically contains below stages:

1. Fuzzification
2. Application of the rule base to fuzzy data
3. Inference of fuzzy results
4. Defuzzification

In the stage of fuzzification, real values are transformed to fuzzy form using membership functions. Rule bases are sets of IF-THEN linguistic rules, which describe a logical evolution of system according to the linguistic values of its principal characters. Combination process of input memberships is used to inference from the IF-part to the THEN-part of one rule. This process is usually done by employing AND, OR or compensatory operators. To aggregate THEN-parts of several rules, several aggregation methods are available. However, Max and Sum are mostly utilized in fuzzy inferences systems. Obtained final fuzzy values from aggregation process are transformed to real data in defuzzification stage. Defuzzification may be done using several methods such as center of gravity, center of maximum, center of area, mean of maximum and so on .Development of a rule based fuzzy model established upon experts' knowledge is down in several stages. In this study, a five steps cycle schemed in Figure1, was followed to complete the final model. This cycle may be repeated even more than one hundred times to provide a reliable final model and in each cycle, one or more factors may be modified. After each cycle outputs of model from real and simulated input data compared whit experts' viewpoints. As model outputs fulfill the experts desire, this cycling will be stopped[5]

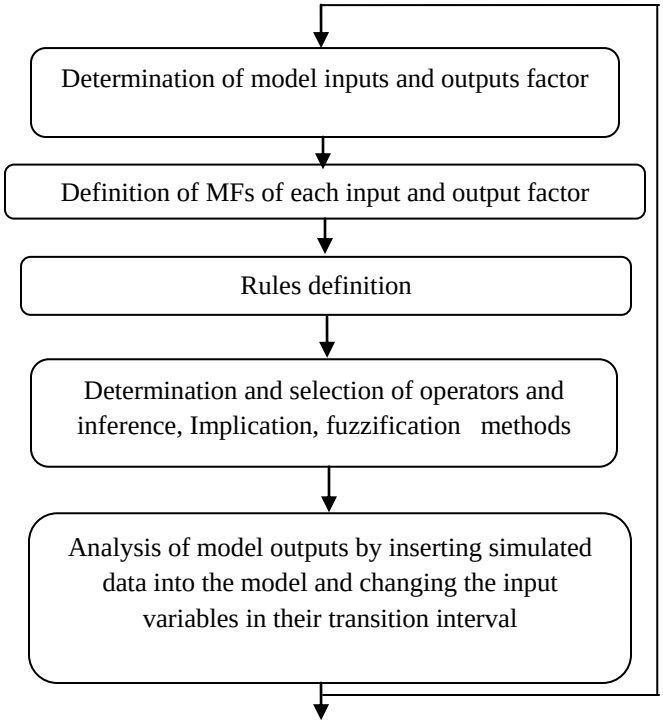

Figure 1: The scheme for the development of fuzzy inference model based on experts Knowledge [5]

B. *Artificial Neural Network*

ANN is considered as simplified model of human brain system. It is a highly parallel distributed processor made up of simple processing units which has a property for storing experiential knowledge and making it available for future use. It has the capability to learn new associations, new patterns and new dependencies. ANN represent the new generation of information processing networks.

ANN has three layers named as input, hidden and output layers as shown in fig 2.Each neuron in the network processes the incoming inputs into an output. The output is then connected to other neurons. The information enters the network at the input layer. All layers of the network process these neurons through the network until they reach the output layer[1]

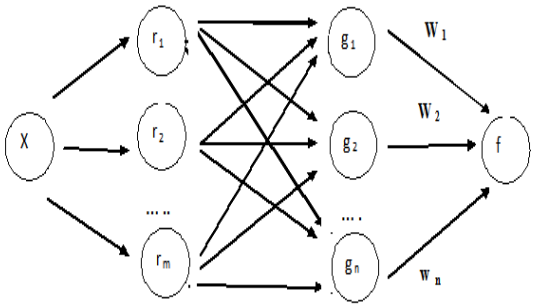

Figure 2. ANN Network Structure [3]

The inputs of a neuron are:(X1,X2,X3…….Xn,w1, w2, ….wn), where Xi represents an ith input, wi represents the ith connection weight and n represents the number of the neuron's input connections. Each node produces an output value O. The process of transformation of any input is described by two functions as

$I=\sum wiXi(i=1 \text{to } n)$

$A=1/(1+e^{-I})$

Where, I represents the standard form of the integration of propagation function that performs a weighted sum for the inputs, and A represents the standard form of the activation function that computes the neuron's output[1].

C. *Genetic Algorithm*

Genetic algorithms (GAs) are benefits arising from the production of a set of Stochastic optimization techniques that mimic the Darwinian evolution by modeling the natural selection process and genetic modifications. They act on a population of individuals that evolve under the effect of three basic operations: selection, crossover and mutation. The parents with high 'fitness' survive and reproduce in order to create individual again more adapted. In the case of standard unimudal GAs, the population quickly converges toward a promising zone of the search space Genetic algorithm (GA) optimization procedures belong to the family of heuristic evolutionary algorithms that mimic the natural evolutionary processes to search optimal solutions for diverse, complex and globally distributed problems. Heuristic optimization methods provide near optimal solutions by searching a global variable space. In brief, a GA consists of a population (represented as chromosome with genes as variables) of solutions that are initialized randomly and their fitness is estimated by evaluating the objective functions. In the selection process, the fittest individuals are duplicated and the weak ones are discarded [4].

II. ANALYSIS OF VARIOUS SOFTCOMPUTING SCHEME

Table1: Table for Crop Production Related Problems and Solving Techniques

Author name and year	Title	Method to solve	Problem
Harsimranjit Singh Narinder Sharma 2014 [6]	A Review of Fuzzy Based Expert System in Agriculture	Fuzzy Logic	Soil preparation Seed selection Pesticide management Water scheduling
Mohammad Mansourifaretal 2013 [4]	Optimization Crops Pattern in Variable Field Ownership	Genetic algorithm	Crop planning Crop pattern
Animesh Biswas, Bijay Baran Pal 2004 [8]	Application of fuzzy goal programming technique to land use planning in agricultural system	Fuzzy logic	Land use planning
Ehsan Houshyar et al 2012 [9]	Sustainable and efficient energy consumption of corn production in Southwest Iran: Combination of multi-fuzzy and DEA modeling	Fuzzy logic Data Envelopment analysis(DEA)	Efficiency of corn production
Yanbo Huang et al 2010 [3]	Development of soft computing and applications in agricultural and biological engineering	Soft computing techniques	crop management precision agriculture
Leila Naderloo et al 2012 [10]	Application of ANFIS to predict crop yield based on different energy inputs	ANFIS	Grain yield of wheat
Alex .B.McBratney et al 1996 [11]	Application of fuzzy sets in soil science: fuzzy logic, fuzzy measurements and fuzzy decisions	Fuzzy system	Soil classification Soil mapping Land evaluation
SnehaMurmu Sujata Biswas 2015 [12]	Application of Fuzzy logic and Neural Network in Crop Classification: A Review	Fuzzy logic Neural network	Crop mapping Estimating crop water requirement
Paulo Salgado et al 2004 [13]	Greenhouse climate hierarchical fuzzy modeling	Hierarchical fuzzy modeling	Green house climate (air temp. and humidity
N. Sundaravall , Dr. A.Geetha 2016 [14]	A Study & Survey on Rainfall Prediction And Production of Crops Using Data Mining Techniques	Fuzzy logic k-mean Neuro fuzzy with genetic algorithm	Prediction of rainfall and crop production
Alastair J. Ward et al 2008 [15]	Optimization of the anaerobic digestion of agricultural resources	Fuzzy logic Artificial neural network	optimization of Anaerobic digestion
C.-C. YANG et al 2000 [16]	Recognition of weeds with image processing and their use with fuzzy logic for precision farming	Fuzzy logic Image processing	Detection of weeds
Asghar Mahmoudi et al 2016 [17]	Simulation of Control System in Environment of Mushroom Growing Rooms using Fuzzy Logic Control	Fuzzy logic simulink	Temperature and humidity in mushroom production
P. Maleki et al [18]	Application of fuzzy logic to land suitability for irrigated wheat	Fuzzy logic	Land suitability for wheat crop
N. Tremblay et al [19]	Fuzzy logic to combine soil and crop growth information for estimating optimum N rate for corn	Fuzzy logic	Optimization of Nitrogen rate
Kartik Ingole et al	Crop prediction and detection using	Fuzzy logic	Crop detection

[20]	fuzzy logic in matlab	Matlab	
E. FitzRodriguez et al 2009 [21]	Yield prediction and Growth Mode characteristics of greenhouse tomatoes with neural networks and fuzzy logic	Neural network Fuzzy logic	Yield prediction Green house climate control
Miss.Snehal S.Dahikar, et al 2014 [22]	Agricultural Crop Yield Prediction Using Artificial Neural Network Approach	Artificial Neural network	Crop yield prediction
Fadzilah Siraj Nureize Arbaiy [23]	Integrated Pest Management System Using Fuzzy Expert System	Fuzzy logic	Pest management
Siti Khairunniza-Bejo et al 2014 [24]	Application of Artificial Neural Network in Predicting Crop Yield: A Review	Artificial neural network	Prediction of crop yield
K.R. Suresh et al 2004 [25]	A fuzzy risk approach for performance evaluation of an irrigation reservoir system	Fuzzy logic	Crop yield Irrigation reservoir decision making
J.H. ssimakopoulos et al 2003 [26]	A GIS-based fuzzy classification for mapping the agricultural soils for N-fertilizers use	GIS Fuzzy logic	Limit of N fertilizer
M. Azaza1 et al 2015 [27]	Fuzzy Decoupling Control of Greenhouse Climate	Fuzzy logic	Green house temp. and humidity control
Guifen Chen et al 2011 [28]	Research of Irrigation Control System Based on Fuzzy Neural Network	Neural network Fuzzy logic	Saving water
P.Lavanya Kumari et al 2014 [29]	Optimum Allocation of Agricultural Land to the Vegetable Crops under n certain Profits using Fuzzy mult iobjective Linear Programming	FMOLP	Optimum cropping pattern
P. A. Saudagar et al 2012 [30]	Design of Fuzzy Logic Controller for Humidity Control in Greenhouse	Fuzzy logic	Controlling humidity
Fahim Jawad et al [31]	Analysis of Optimum Crop Cultivation Using Fuzzy System	Fuzzy logic	Optimum crop cultivation
Dattatray angaram Regulwar et al 2010 [32]	Fuzzy Approach Based Management Model for irrigation Planning	MOFLP	Crop planning Optimal cropping pattern
Pravin Kumar et al 2017 [33]	Efficiency measurement of fertilizer manufacturing organizations using Fuzzy data envelopment analysis	FDEA	Rank and efficiency of fertilizer
Miss. Sarika A. Hajare et al 2015 [34]	Fuzzy based approach for weather advisory system	Fuzzy logic	Weather advisory approach
Marcel G. Schaap et al 1998 [35]	Neural Network Analysis for Hierarchical Prediction of Soil Hydraulic Properties	Neural network	Soil properties
Dinesh K. Sharma et al 2009 [36]	Fuzzy goal programming based genetic algorithm approach to nutrient management for rice crop planning	Genetic algorithm FGP	Nutrient – management decision making
Murali Siddaiah et al 2009 [37]	Identification of Trash Types in Ginned Cotton using Neuro Fuzzy Techniques	Fuzzy logic Neural network	Identification of trash

Moussa waongo et al 2013 [38]	A Crop Model and Fuzzy Rule Based Approach for Optimizing Maize Planting Dates in Burkina Faso, West Africa	Fuzzy logic	Optimize crop planting date
S. M. Wu et al [39]	An interactive inexact-fuzzy approach for multi objective planning of water resource systems	FMOP	Water pollution control
Dinesh K. Sharma et al 2007 [40]	Fuzzy goal programming for agricultural Land allocation problems	FGP	Allocation of land

III. CONCLUSION

Here soft computing techniques are used in crop production. In this paper we have surveyed different problems and techniques. This survey table is very useful to understand problems and corresponding problem solving technique. All these techniques have their own advantages and disadvantages and gives a better way to improve the crop production which leads to precision agriculture [7].

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