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An Efficient Neuro-Fuzzy-Genetics Approach for Multi Criteria Decision Making

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Abstract

The present paper, we applied combined neural network, fuzzy logic and genetics algorithm approach to multi criteria decision-making in different areas. The paper begins with introduction and literature review followed by some fundamental of fuzzy set theory, neural network and genetics algorithm and methodology to apply them in multi criteria decision-making, which provides a better level of satisfaction to obtain the better decision.

***Keywords**: Fuzzy logic, Neural Network, Genetics Algorithm and Multi-Criteria Decision*

1. Introduction

In the present it has become more and more obvious that comparing different ways of action so far desirability, judging the suitability of products or determining optimal solution in decision making problem can be done by multi-criteria decision making, which leads to numerous evaluation schemes in mathematical programming. Broadly the two aspects MODM and MADM of multi-criteria decision analysis deal with two types of problems: the continuous decision spaces on mathematical programming with several objective functions and discrete spaces. Decision-making under risk or uncertainty has been modeled by application of probability or game theory. Decision making to deal with vagueness or fuzziness is dealt with fuzzification of classical decision theory. Soft computing such as Fuzzy-Genetics, Neuro-Genetics, Neuro-Fuzzy techniques have been applied for different optimization problems and attempts are being made to use these techniques in decision theory.

Decision making is one of the most fundamental activities of the human being. In our daily life all are facing problems where we have to decide which of the available actions to take. Decision theory suggests the study of how decisions are actually made & how they can be made better to be implemented more successfully. So decision making itself is broadly defined to include any choice or selection of alternatives in many fields in both “Soft” social sciences and the “Hard” natural and engineering sciences. . Much of the focus is in the area of management sciences with key importance for functions such as inventory control, investments, personal actions, new products development, allocation/ assignment problems and many more..

Bellman and Zadeh [1] descried the classical model of decision-making in fuzzy environment. Yager, R.R [2, 7] descried fuzzy decision-making including unequal objectives. Weirzchon, S.T [5] published application of fuzzy decision theory to coping with all defined problems. Zimmerman, H.J [3] introduced the fuzzy set decision-making and expert system. Kosko [4] has shown fuzzy systems are universal approximators in the fact that they exhibit the capability to approximate general non-linear function to any desired degree of accuracy. Schaffer *et al.*, [6] proposed Neuro-Genetics hybrid system. Ishibuchi *et al.*, [9, 10, 11, 12] was descried the genetics approach and fuzzy rule to the problems of fuzzy system adaptation respectively. Yeh and Lee [8] showed the application of Neuro-Fuzzy hybrid modeling.

Our contribution: As outlined in the above, we used, Neuro-Fuzzy, Neuro-Genetics and Fuzzy-Genetics techniques for the mathematical programming problems to have an optimal solution and apply Neuro-Fuzzy-Genetic Algorithms to get better optimal/ approximate/ compromise solution in the present work.

Organization: The remainder of this paper is organized as follows: Section 2 descried Neuro-Fuzzy-Genetics Approach. Conclusion is given in the final Section 3.

2. An Efficient Neuro-Fuzzy-Genetics Approach

In the view of recent developments is available in the literature. We proposed an efficient Neuro-Fuzzy-Genetics Algorithms approach to determine optimal solution in multi-criteria decision-making problem the basic computational units of neural networks are artificial neurons. A single neuron has n inputs $x_1, x_2, \ldots\ldots\ldots., x_n$ whose values are real numbers and one output y. Input of neurons is associated with real numbers $w_1, w_2, \ldots\ldots\ldots., w_n$ referred as weights. The output depends on $\sum_{i=1}^{n} w_i x_i$ it terms of nonlinear functions. The most common activation function defined by

$$h(a) = \begin{cases} 1 & a \geq 0 \\ 0 & a < 0 \end{cases} \quad \text{for all } a \in \Re \text{ and}$$

the class of Sigmoid function defined by $S_\beta(a) = \left(1 + e^{-\beta a}\right)^{-1}$ where β is positive whose value satisfies a particular Sigmoid function in this class.

Then output of neurons is defined as $y = S_\beta(\sum_{i=1}^{n} w_i x_i - \theta)$ for some $\beta \in \Re^+$ where θ is the bias of neuron. For the convenience we are taking $x_0 = 1$ and $w_0 = \theta$, then the output neuron is given by $y = S_\beta(\sum_{i=0}^{n} w_i x_i)$.

The classical decision-making deals with a set of alternatives consisting of decision space, state space, a relation among them and an objective function. Decision-making under risk or uncertainty has been modeled by application of probability or game theory. Decision making to deal with vagueness or fuzziness inherent with many processes is dealt with fuzzification of classical theory. If in any decision relevant alternatives are evaluated according to a number of criteria or analysis then that decision is termed as multi-criteria decision analysis. In this criteria number of criteria assumed to be finite and the selection of number of alternatives are also finite.

Let $A = \{a_1, a_2, \ldots\ldots\ldots, a_n\}$ be a set of alternatives and $C = \{c_1, c_2, \ldots\ldots\ldots, c_n\}$ be a set of decision situations. The information involved in multi-criteria decision-making can be expressed as the matrix

$$R = \begin{array}{c} \\ c_1 \\ c_2 \\ \cdots \\ c_m \end{array} \begin{array}{c} \begin{array}{cccc} a_1 & a_2 & \cdots & a_n \end{array} \\ \begin{bmatrix} r_{11} & r_{12} & .. & r_{1n} \\ r_{21} & r_{22} & .. & r_{2n} \\ \cdots & \cdots & .. & \cdots \\ r_{m1} & r_{m2} & .. & r_{mn} \end{bmatrix} \end{array}$$

where all entries of this matrix are real number in [0, 1] and each entry c_{ij} expresses the degree to which criterion c_i is satisfied by the alternatives a_j such that $(i \in \mathrm{N}_m, j \in \mathrm{N}_n)$. The matrix R is the representation of fuzzy relation on $C \times A$.

Sometimes it may happen instead of matrix R with entries [0, 1], an alternative matrix $R' = [r'_{ij}]$, whose entries are arbitrarily real number, where R' can be converted to R by

$$r_{ij} = \frac{r'_{ij} - \min_{j \in N_n} r'_{ij}}{\max_{j \in N_n} r' - \min_{j \in N_n} r'} \text{ for all } (i \in \mathrm{N}_m, j \in \mathrm{N}_n).$$

The new efficient approach is to convert multi-criteria decision to single criteria decision problem which can be done by finding a criterion $r_j = h(r_{1j}, r_{2j}, \ldots\ldots\ldots, r_{mj})$ that for each $a_j \in A$ is an adequate aggregate of values $r_{1j}, r_{2j}, \ldots\ldots\ldots, r_{mj}$ to which individual criterion are satisfied.

The fuzzy constraints and fuzzy goals defined as a function

$$\mu_C : X \to [0,1]$$
$$\mu_G : Y \to [0,1]$$

When X is a set of possible actions, Y is the set of possible outcomes. The fuzzy decision is given by the membership function

$$\mu_D(x) = \min\ [\mu_C(x), \mu_G(x)],\ x \in X$$

The fuzzy model can be further extended to weighted goals and weighted constraints such as: $\mu_D(x) = \sum_{i=1}^{n} u_i \mu_{G_i}(x) + \sum_{j=1}^{m} u_j \mu_{C_j}(x)$ where u_i, u_j are weights for fuzzy goals G_i and fuzzy constraints C_j such that $\sum_{i=1}^{n} u_i + \sum_{j=1}^{m} u_j = 1$.

Then group decision for n persons on a set X of alternatives a social preference S defines as a fuzzy binary relation with membership function $\mu_D : X \times X \to [0,1]$. Which are assigning the membership grade $\mu_S(x_i, x_j)$, indicating the degree of group preference of alternatives x_i over alternatives x_j.

Let $\mu_S(x_i, x_j) = \frac{N(x_i, x_j)}{n}$ where $N(x_i, x_j)$ is the number of persons preferring x_i to x_j. After that fuzzy logic controlled genetics algorithm base structural optimization applied to get optimum solution, which is divided, into three stages fuzzification, fuzzy inference and defuzzification.

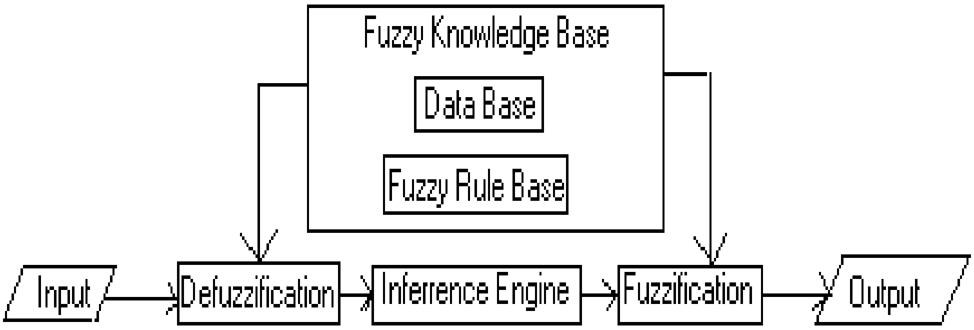


Figure 2.1. Genetics Algorithm

By using above Genetics algorithm, apply the following steps and techniques to evolve a best possible decision.

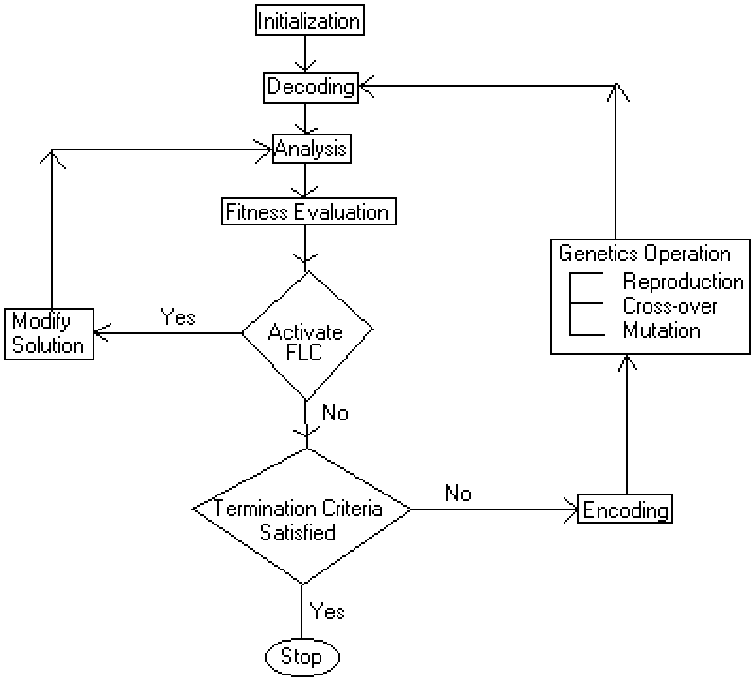


Figure 2.2. Efficient Neuro-Fuzzy-Genetics Algorithms

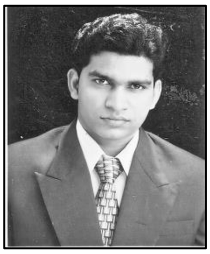
3. Conclusion

The theory makes the use of Neural Network, Fuzzy Logic and Genetics Algorithm. Neural Networks are massively parallel, highly interconnected networks of processing elements called Neurons. Neural Networks are highly simplified models of human nervous system, which mimic our ability to adapt the circumstances & learn from the past experience. Fuzzy logic is an excellent mathematical tool to model uncertainty in system. Fuzzy Logic systems addresses the uncertainty or vagueness input output description of systems using fuzzy set which have no crisp boundaries and provide a gradual transition between membership and non-membership of elements in a set. Genetics Algorithm inspired by the process of biological evolutions is adaptive search and optimization algorithm. The proposed approach provided better optimal/ approximate/ compromise solution in mathematical programming techniques

Reference

[1] R. E. Bellman and L. A. Zadeh, "Decision-Making in Fuzzy Environment", Management Science, vol. 17, **(1970)**, pp. 141-164.
[2] R. R, Yager, "Fuzzy decision making including unequal objectives", Fuzzy Sets and System, vol. 1, **(1978)**, pp. 87-95.
[3] H. J. Zimmerman, "Fuzzy Set Theory and Its Applications", Kluwer Academic Publishers Boston/Dordrecht/London, **(2001)**.
[4] B. Kosko, "Neural Networks and Fuzzy Systems", Prentice Hall of India Pvt. Ltd. **(2001)**.
[5] S. T. Wierzchoń, "Applications of fuzzy decision-making theory to coping with ill-defined problems", Fuzzy Sets and Systems, vol. 7, no. 1, **(1982)**, pp. 1-18.
[6] D. Schaffer, D. Whitley and L. Eshelman, "Combinations of Genetic Algorithms andNeural Networks: A survey of the state of the art," Proceedings of the International Workshop on Combinations of Genetic Algorithms and Neural Networks. D. Whitley and D. Schaffer (Eds.,) Los Alamitos, CA: IEEE Computer Society Press, **(1992)**, pp. 1-37.
[7] R. R.Yager, "On the Interface of Fuzzy Sets and Neural Networks", In InternationalWorkshop on Fuzzy System Applications, **(1988)**, pp. 215–216.
[8] R.R. Yager and D.P. Filev, "Adaptive Defuzzification for Fuzzy System Modeling", In Proceedings of the Workshop of the North American Fuzzy InformationProcessing Society, **(1992)**, pp. 135–142.
[9] C. Y. Yeh and S. J. Lee, "Application of type-2 neuro-fuzzy modeling in stock price prediction", Journal Applied Soft Computing, vol. 12, no. 4, **(2012)**, pp. 1348-1358.
[10] H. Ishibuchi, K. Nozaki and H. Tanaka, "Distributed representation of fuzzy rules and its application to pattern classification", Fuzzy Sets and Systems, vol. 52, pp. 21-32, **(1992)**.
[11] H. Ishibuchi, K. Nozaki and H. Tanaka, "Efficient fuzzy partition of pattern space for classification problems, Fuzzy Sets and Systems, vol. 59, **(1993)**, pp. 295-304.
[12] H. Ishibuchi, K. Nozaki and N. Yamamoto, "Selecting fuzzy rules by genetic algorithm for classification problems, Proc. 2nd IEEE Internat. Conf. on Fuzzy Systems (San Francisco, CA) **(1993)** March 28-April 1, pp. 1119-1124,
[13] H. Ishibuchi, K. Nozaki, N. Yamamoto and H. Tanaka, "Genetic operations for rule selection in fuzzy classification systems, Proc. 5th IFSA World Congr., Seoul, Korea, **(1993)** July 4-9, pp. 15-18.

Authors



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