Research of cooperative decision-making based on Hybrid Neuro-Fuzzy System

Sangita Lalchand Vaswani, Muhammad Mazhar Manzoor, Asad Ali Siddique, Amir Ijaz

Abstract— A considerable advancement has been appreciated since very long in DSS framework and deployment of that in DSS. But the cognitive process execution and associative memory for storing the serial characters is an issue for DSS. The spectrum of neural networks is actually a huge platform to identify the hidden relations in dynamic systems, to resolve the problems in a way that linear systems can not resolve. Fuzzy-logic (FL) is an approach of solving the problems and the controlling the systems. Through FL definite conclusions can be received, even if the information is unclear, not complete, and splitting. Building DSS with hybrid neuro-fuzzy system gives us a new thought to develop intelligent DSS in cooperation with artificial intelligence. Hybrid neuro-fuzzy systems (Adaptive-Network-Based Fuzzy Inference System ANFIS) is a parallel architecture, distributive processing, system's adaptive nature for linguistics (low, medium, high), non-linear perspective, while realizing the real time processing. In this paper we have discussed the uncertain factors of DSS, explained cognitive processing steps of hybrid neuro-fuzzy systems, and proposed a research framework for cooperative decision support system in relation with neural network and hybrid neuro-fuzzy systems.

Index Terms— Adaptive Network-Based-Fuzzy Inference System, , Data Mining, Decision Support System, Fuzzy Logic , Hybrid Neuro-Fuzzy System, Intelligent Decision Support System, Knowledge Base, Neural Network.

1 INTRODUCTION

DECISION Support System (DSS) is principally a human-computer cooperated system, used to work out the non-organized or semi-organized problems. The fundamentals of conventional DSS to resolve the problems is not up to the level of satisfaction, but consistent decisions can be produced through DSS with the significant development of co-operating the multiple models completely, referring the intensive set of knowledge and the direct interaction of human with computer. Ability of conventional Expert System's is sometimes not affected, therefore, the authors have proposed cooperative DSS to work in cooperation with Neuro-Fuzzy System to make intelligent decision support system for cooperative decision-making.

The neural network is actually a ultra large scale computing system to distinguish the hidden connections in dynamic systems, to resolve the problems that linear systems can not resolve. The essential part of neural network is the adjusting quality of neurons to fulfill the parallel the distribution by managing the internal and external weights and it continues through the entire network.

Fuzzy-logic (FL) is actually an approach of solving the problems and the controlling the systems. Through FL definite conclusion comes around, even if the information is unclear, not complete, and splitting. The methodology of

FL to handle the processing states is simply like a human dealing with situations at a faster rate.

Integration of these two makes a hybrid neuro-fuzzy system, based on general facts like of human justifications in relation with hidden connections. Therefore the study of cooperative decision-making integrating with hybrid neuro-fuzzy system has a great theoretical and practical impact. ANFIS (Adaptive Network Based Fuzzy Inference System) is a 5-layer feed forward neuro fuzzy system proposed by j-s jang and supports only sugeno type systems.

2 RESEARCHES ON CO-OPERATIVE DECISION MAKING

Decision support system is viewed very powerful accompanying with the comprehensive management system and the operations research. Figure 1 shows the general architecture of decision support system.

In order to obtain the intelligent inference we have two structure modes, one is operation mode that is comprehensive management system and the other is language mode that is user interface. The possible set of executable data is provided by data base to decision region for CMS. Method library holds contains the algorithms for resolving the problems and determining the solutions. Model base management contains Model generator and

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model library. Model generator generates realistic test models for model library. A considerable advancement has been appreciated since very long in DSS framework and deployment of that in DSS. But the cognitive process execution and associative memory for storing the serial characters is an issue for DSS.

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A considerable advancement has been appreciated since very long in DSS framework and deployment of that in DSS. But the cognitive process execution and associative memory for storing the serial characters is an issue for DSS. The major uncertain areas of DSS are:

- Reliability is mostly affected in DSS applications as mostly DSS are deployed under non-real-time environment.
- Weak connection between quantitative and qualitative analysis that eventually reduces the chances of intelligent inferences as it is always dependent on the stronger connection of qualitative and quantitative facts which are generated from past experience and the weight of hidden connections.
- Knowledge acquiring DSS is specifically a responsibility of knowledge engineers' to feed the simulated knowledge into DSS. And it decreases the ratio of intelligent inferences as the knowledge is transporting from one end to another.

3 INTEGRATION OF A NEURAL NETWORK AND HYBRID NEURO-FUZZY LOGIC

Neural network is similar to a finite state machine that is non-linear dynamical system. By combining with fuzzy logic it makes a hybrid structure. And this sort of structure is very well fitted for numerical and linguistic knowledge. Building DSS with neuro-fuzzy system gives us a new thought to develop intelligent DSS in cooperation with artificial intelligence, where difficulty involves in knowledge acquisition and deriving intelligent inference. Like neural networks hybrid neuro-fuzzy system gives us parallel architecture with distributive processing, system's adaptive nature for linguistics, non-linear perspective, and real time processing. Because of all these essential qualities of hybrid neuro-fuzzy systems, decision making ability of DSS ameliorate.

As data, knowledge and model are the significant sources of intelligent IDSS. Figure2 shows the proposed model of

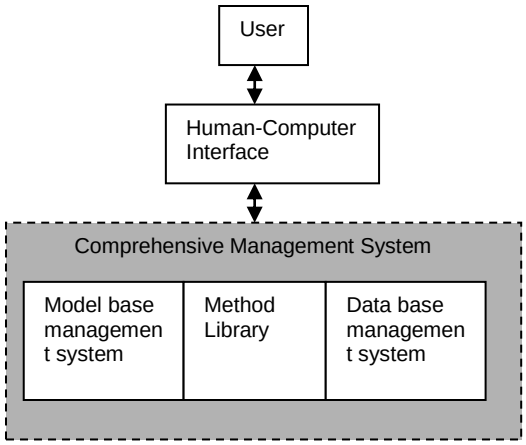

Figure 1 *general architecture of Decision Support*

research framework of IDSS associates with hybrid neuro-fuzzy system for intelligent inference and data mining.

IDSS is principally provided with data, knowledge, and model in cooperation of Neuro-fuzzy and data mining. Through data mining steps, system becomes capable to select the mode from actual values of data.

We have used adaptive network based fuzzy inference system, whose fuzzy rules are of the following kind.[eq1]

$$R_p: \text{if } x_1 \text{ is } A_1^P \text{ and } x_2 \text{ is } A^P{}_2 \ldots\ldots \text{and } x_n \text{ is } A_n^p \quad \text{then } O^p = \alpha^p{}_{0+}\alpha_1{}^P x_{1+\ldots\ldots\ldots+}\alpha_n{}^p x_n \qquad (1)$$

Xi is the ith input of linguistic variable of the pth rule in the antecedent part, A_i^P is the label for linguistic, aggregated with pth rule and has fuzzy membership function $\mu_{A_i^P}(x_i)$, $\alpha^P{}_0$ is the Sugeno parameter, O^P is the output parameter of pth rule.

Every node on the first layer is distinguished with its comparable output using the determined linguistic variables, through the mapping functions of linguistic variables the crisp input x1 and x2 are fuzzified [fuzzification]. Second layer contains rules defined on every node (fuzzy *if-then*), because it is connected with those nodes in first layer which formed the antecedent of this rule. (Rule nodes). On the third layer normalization is performed on the strength of fuzzy rules. 'Then part' of the fuzzy rules are considered in the fourth layer. Finally on the fifth layer output is computed.

Therefore, it is thought that this commonly used hybrid neuro-fuzzy system architecture would well suit with DSS and overcome many problems that DSS face. It has better performance in non-linear functions, online control, training time, chaos time series and network optimization.

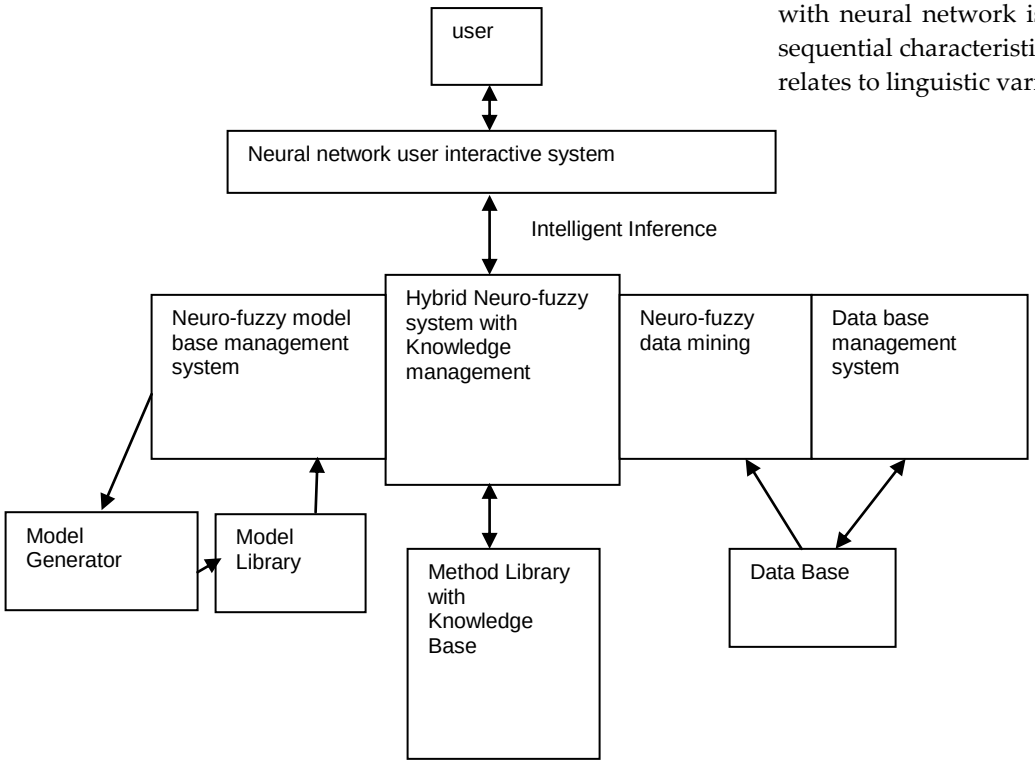

Figure 2 *proposed framework of IDSS with hybrid neuro-fuzzy system (ANFIS)*

Method of problem solving is the inference of knowledge. Inference systems are basically dependent on neuro-fuzzy network with data reasoning and goal driven. And to elaborate the inferencing, here we take continuous bidirectional associative memory (CBAM). We assume here that we have, sigmoidal neuron functions. And neurons on every layer are ruled by additive dynamics systems. We can express it with equation 5 and equation 6.
Target driven and data driven approaches are shown through the equations 5 and 6 respectively. Thus the local minima will consequently be considered by continuous BAM in relation with the previously placed pattern.

That is CBAM puts complete or incomplete values of Xi to the output of the input layer after fuzzification and then they propagated onwards, a comparable output on the second layer is formulated, and it also produces the related vector on the output of the first layer through the transposed matrix. Vector values of X are then distributed to every neuron of the operation layer. Here the network undergoes to a stable state as the strength of wining neurons is calculated at this layer. And finally_after the performing normalization while considering the fuzzy rules output vector is formed. This computation continues until the network reaches a stable state.
Understanding of natural language processing situated with neural network is basically depends on discreteness, sequential characteristics, and adjacency. Natural language relates to linguistic variables, of inconsistent magnitude.

alysis methods are the major areas of natural language processing with neural network. So it is a thought to
apply statistical natural language processing, because it uses probabilistic, statistical and stochastic methods to resolve many difficulties, such as lengthy sentences are mostly ambiguous when prepared for neural network.

$$O_i^1=\mu_{Ai}{}^P(x), \quad (2)$$

$$O'p=W'p*Op \quad (3)$$

$$O^*=\sum_p O'p \quad (4)$$

$$\text{input} \quad x_i = \sum_{J=1}^{n} w_{ij}o_j \qquad i=1,2,\ldots..,m \qquad (5)$$

$$\text{output} \quad o_i = \sum_{i=1}^{m} w_{ij}(x_i) \qquad j=1,2,\ldots.,n \qquad (6)$$

Technology of statistical natural language processing is effective in terms that it is based on data mining and machine learning. The idea of implementing the natural language with neural network is to interpret the knowledge facts and this can effectively maps the conception of natural

language on to the processing unit of neural network, as the processing steps of both are similar in finding the connection strength by weight and activation of neurons.

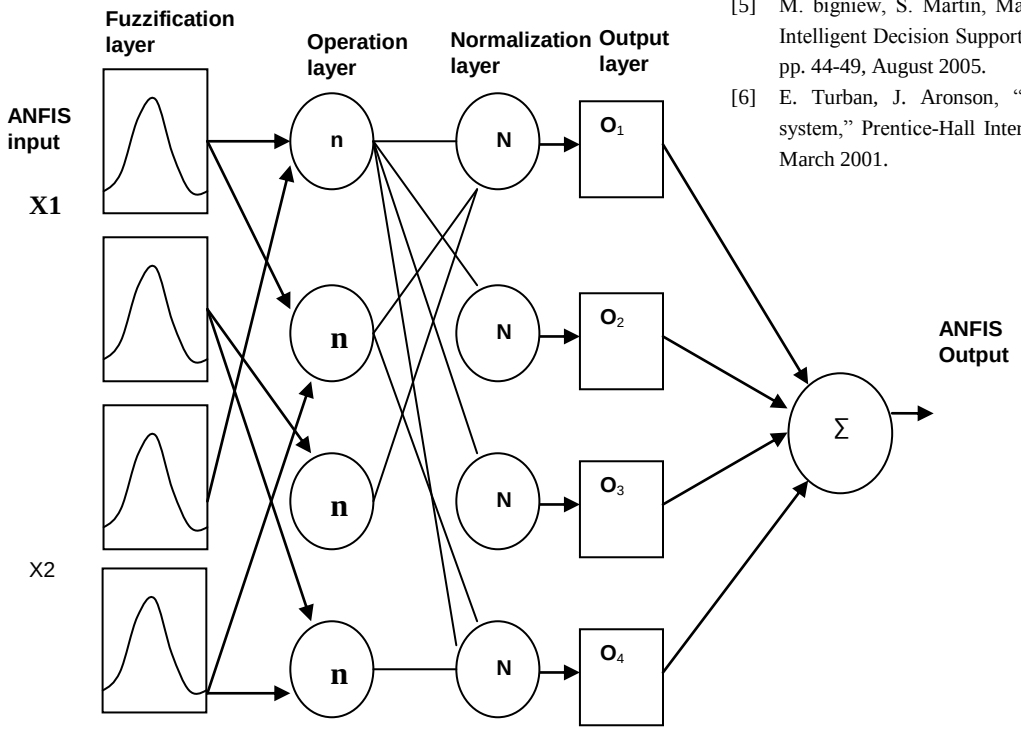

Figure 3 5 layer Adaptive neuro-fuzzy inference system architecture. *source adopted from book "soft computing and intelligent design systems" author, "fakhreddine O.karray and Clarence de silva"proposed by j-s jang*

4 CONCLUSION

The objective of this research is to apply the neuro-fuzzy systems in DSS research, presenting the neuro-fuzzy technology to DSS research, in contrast with knowledge and hybrid neuro-fuzzy network models and the comprehension of cooperative decision-making. Practical analyses in this research are encouraging, but at this time there are many questions exist which requires complete exhaustive research.

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