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Review of Expert Systems based on Fuzzy logic

Er. Navjot Kaur[1], Er. Navleen Singh Rekhi[2], Anand Nayyar[3]

M.Tech (ECE) Scholar, DAVIET, Jalandhar[1]

Assistant Professor, Department of Electronics and Communications Engineering, DAVIET Jalandhar[2]

Assistant Professor, Department of Computer Applications & IT, KCL Institute of Management and Technology, Jalandhar, Punjab[3]

Abstract: Expert system is a computer system that emulates the decision making ability of a human expert. That is it acts in all respects like a human expert. It uses human knowledge to solve problems that would require human intelligence. The expert system represents expertise knowledge as data or rules within the computer. These rules and data can be called upon when needed to solve problems. Expert systems have been developed in such diverse areas as science, engineering, business, and medicine. In these areas, they have increased the quality, efficiency, and competitive leverage of the organizations employing the technology. The scientists and engineers have used this technology to search for oil, diagnose medical problems, and explore space. This paper provides an overview of this technology and highlights the major characteristics of expert systems with fuzzy logic along with an overview of various expert systems based on fuzzy logic.

Keywords: Fuzzy Logic, Neurofuzzy, Expert System, Fuzzification, Defuzzification

1. INTRODUCTION

Expert system technology has captured the interest of professionals in a number of fields in recent years. Systems have been developed in such diverse areas as science, engineering, business, and medicine. Almost every professional and computer society currently has a special interest group for expert systems technology. This widespread interest can be attributed to the ability of the expert system to aid various organizations in solving practical, real-world problems. Currently, over two-thirds of the Fortune 1000 companies have expert system projects under development . Organizations are looking toward these systems to aid them in increasing the quality, efficiency, and competitive leverage of their operations. Expert systems have been used in a wide range of applications in the area of science. Scientific and technology-oriented organizations have applied expert systems underground to find oil or mineral deposits , in space to help control various spacecrafts, and on earth to help in diagnosing medical problems. Expert systems can aid scientists by interpreting data from an experiment, interact with a physician to identify a given disease, or aid an engineer in controlling a particular process.[1]

1.1Literature Review

[1] John Durkin "Application of Expert System In Science" says that An expert system is a computerprogram which captures the knowledge of a human expert on a given problem, and uses this knowledge to solve problems in a fashion similar to the expert. The system can assist the expert during problem-solving, or act in the place of the expert in those situations where the expertise is lacking.

[2] Mario A Garcia, "An Expert System In Diabetes" describes the steps followed to implement ESDIABETES. Diabetes is a disease that affects many people in the world. Diabetes cost in the U.S.A. is estimated to represent 5.8% of total personal health-care expenditures. In Europe diabetes is estimated to consume about 10% of the total health care budget Patients with diabetes need to maintain a normal blood glucose level. ESDIABETES was developed by computer science graduate students at Texas A&M University Corpus Christi to help people monitor and control the blood glucose level.

[3] Rahul Malhotra, "Fuzzy Logic Modeling simulation and Control" explores an applicability of fuzzy logic to tackle process controllers. The performance of different process controllers have been analyzed using fuzzy logic approach. The various steady state and transient response parameters have been investigated and the errors can be estimated by Integral of absolute error (IAE) and Integral of time absolute error (ITAE). The comparative result shows the superiority of fuzzy logic than conventional controllers.

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[4]Dr. A.V Senthil Kumar" Fuzzy Expert System for Diabetes using Fuzzy Verdict Mechanism" The fuzzy logic and expert system is an important technique to enhance the machine learning reasoning. Author proposes a fuzzy expert system framework which constructs large scale knowledge based system effectively for diabetes. The knowledge is constructed by using the fuzzification to convert crisp values into fuzzy values. By applying the fuzzy verdictmechanism, diagnosis of diabetes becomes simple for medical practitioners.

[5] Yasser Abdelhamid "A Proposed Methodology For Expert System Engineering". Explained that the development methodology of an expert system has two aspects: Knowledge engineering, and Software engineering. From the software engineering aspect, there are four activities for expert system development: requirements specification, design, implementation, and testing. The paper included a detailed specification of each of these activities.

[6]Bob Jansen" Two Expert System Applications: Implications for Knowledge Representation for Explanations and Justifications" This paper discusses interim results from a research project into knowledge representation facilitating explanation and justification in knowledge-based systems. The research program has its roots in the re-development of an expert system and the effect of this application on the acquisition and representation of the knowledge to facilitate explanations and knowledge justification.

1.2 Fuzzy Logic

Fuzzy logic attempts to systematically and mathematically emulate human reasoning and decision making. It provides an intuitive way to implement control systems, decision making and diagnostic systems in various branches of industry. Fuzzy logic represents an excellent concept to close the gap between human reasoning and computational logic. Variables like intelligence, credibility, trustworthiness and reputation employ subjectivity as well as uncertainty. They cannot be represented as crisp values, however their estimation is highly desirable. Systems are emerging technologies targeting industrial applications and added a promising new dimension to the existing domain of conventional control systems. Fuzzy logic allows engineers to exploit their empirical knowledge and heuristics represented in the IF-THEN rules and transfer it to a functional block. Fuzzy logic systemscan be used for advanced engineering applications such as intelligent control systems, process diagnostics, fault detection, decision making and expert systems.[3]

1.3 Neuro fuzzy

In the field of artificial intelligence, neuro-fuzzy refers to combinations of artificial neural networks and fuzzy logic. Neuro-fuzzy hybridization results in a hybrid intelligent system that synergizes these two techniques by combining the human-like reasoning style of fuzzy systems with the learning and connectionist structure of neural networks. Neuro-fuzzy hybridization is widely termed as Fuzzy Neural Network (FNN) or Neuro-Fuzzy System (NFS) in the literature. Neuro-fuzzy system (the more popular term is used henceforth) incorporates the human-like reasoning style of fuzzy systems through the use of fuzzy sets and a linguistic model consisting of a set of IF-THEN fuzzy rules as shown the model of neuro-fuzzy in fig.1. The main strength of neuro-fuzzy systems is that they are universal approximations with the ability to solicit interpretable IF-THEN rules. The strength of neuro-fuzzy systems involves two contradictory requirements in fuzzy modeling interpretability versus accuracy. In practice, one of the two properties prevails. The neuro-fuzzy in fuzzy modeling research field is divided into two areas linguistic fuzzy modeling that is focused on interpretability, mainly the Mamdani model and precise fuzzy modeling that is focused on accuracy, mainly the Takagi-Sugeno-Kang (TSK) model. A lot of research is devoted to improve the ability of fuzzy systems,such as neural networks.

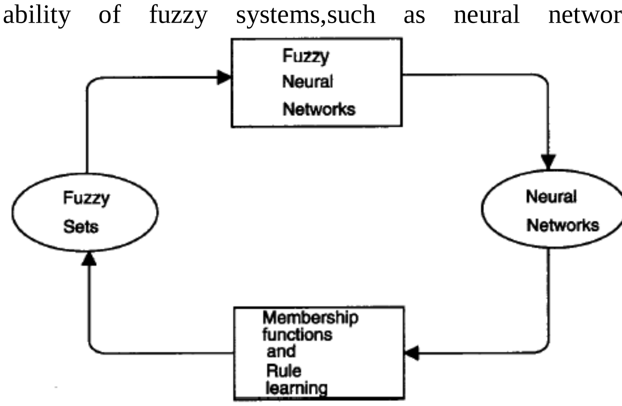

Fig.1http://en.wikipedia.org/wiki/Neuro-fuzzy

1.4 Expert System

An expert system is a computer program designed to model the problem-solving ability of a human expert. The program models the following characteristics of the human expert: Knowledge, Reasoning,Conclusions, and Explanations. The expert system models the knowledge of the human expert, both in terms of content and structure. Reasoning is modeled by using procedures and control structures which process the knowledge in a manner similar to the expert. Conclusions given by the system must be consistent with the findings of the human expert. The expert system also provides explanations similar to the human expert. The system can explain "why" various questions are being asked, and "how"

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a given conclusion was obtained. One of the principal attractions of expert systems is that they enable computers to assist humans in many fields endeavor with the processes of analyzing and solving complex problems. They extend the application of computers beyond the conventional mathematical processes we have customarily assigned computers, to applications where the computer can carry on a somewhat natural conversation with the user to arrive at a conclusion or recommendation that aids the human decision-maker. This is accomplished by encoding in the expert system the knowledge and problem-solving skills of a human expert. This expert computer program can then be used by others to obtain and use this expertise for solving a current problem that would have previously required the expert to be present.[1]

2. Why use an expert system?

Like any project venture, developing an expert system must have some justification. Insight for justifying an expert system can be gained when one compares an expert system with a human expert. From the comparison one can formulate several general reasons for employing an expert system such as: Replacement of human expert Assistant to human expert Transfer of expertise to novice Using an expert system to replace a human expert is done primarily to use the system when the expert is not available. For example, through time constraints, the human expert may not be available, while an expert system designed to control some manufacturing process would be available 24 hours a day. Another expert system, containing the expertise of a unique expert within a company, could be made available to company sites located in other geographic areas. If the expert should leave or retire from the company, the expertise captured in the expert system could serve as a replacement for the expert. Human experts may be scarce, hence expensive. Expert systems, by contrast, may be inexpensive. Developing an expert system can be a costly venture, but the finished product would have low operating costs. The finished system can also be duplicated at low cost and distributed widely. In the area of science, justifying an expert system for replacing a human can be foundin such applications as space exploration or providing the expertise of a geophysicist to some remote oil exploration site .Another example would be to replace the human operator of a control process

Assisting a human expert is one of the most commonly found applications of expert systems. In this application, the expert system attempts to aid the human expert in a routine or mundane task. For example, a physician may have general knowledge of most diseases, but could use some additional support in diagnosing a given problem with a patient. In another example, a bank manager may be responsible for processing numerous loan applications, but could use help with some of the routine decisions made. In both applications, the human expert is fully capable of performing the task, but obtains additional support from the expert system. In this type of expert system application, the objective is to improve the overall productivity of the current practice. The most common learning method used in expert today is a technique known as induction . The induction technique works with information contained in a set of examples to induce a set of rules which capture the knowledge about the problem. This approach has particular value for those problems where the expert lacks the knowledge to form decisions, but has a history of data on the problem. The induction technique can uncover classifications in the data which can be used for guiding the decision process. The expertise held by a human expert is a valuable resource. Knowledge is gained by the expert through years of experience from working on the problem. In many organizations, it is important that this expertise not be lost, but transferred to others through training. An expert system can be developed to accomplish this training task.

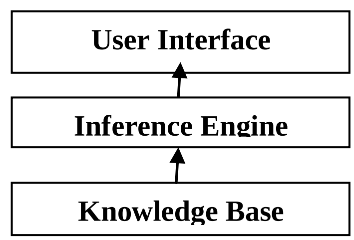

Fig.2 Basic block diagram of Expert System

3. Different Expert Systems

There are many different types of expert systems. The following list describes the various types.

1.Diagnosis: Diagnosis types of expert systems are used to recommend remedies to illnesses, trouble-shoot electronic or mechanical problems or as debugging tool.

2.Repair: Expert systems that define repair strategies are also very common. As well as diagnosing the problem they can suggest a plan for the repair of the item. The repair plan typically contains a scheduling structure and some control structure to validate the repair process. Such systems have been employed in the automotive repair field and similar areas.

3.Instruction: Instructional expert systemshave been used for individualized training or instruction ina particular field. The system presents material in an order determined by its evaluation of the user's ability and current knowledge and monitor's the progress of the student, altering the sequence depending on this progress.

4.Interpretation: Interpretive expert systems have the ability to analyze data to determine its significance or usefulness. The knowledge base often contains models of

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real world situations which it compares to its data. These are often used in exploration for mineral, gas and oil deposits as well as in surveillance, image analysis and speech understanding.

5.Prediction: Predictive expert systems are used as a method to "guess" at the possible outcomes of observed situations, usually providing a probability factor. This is used often in weather forecasting.

6.Design and Planning: This allows experts to quickly develop solutions that save time. These systems do not replace experts but act as a tool by performing tasks such as costing, building design, material ordering and magazine design.

7.Monitoring and Control:In certain applications expert systems can be designed to monitor operations and control certain functions. These are particularly useful where speed of decision making is vitally important, for example in the nuclear energy industry, air traffic control and the stock market.

8.Classification/Identification: These systems help to classify the goals in the system by the identification of various features (these can by physical or non-physical) For example various types of animals are classified according to attributes such as habitat,feeding information, colour, breeding information, relative size etc. These systems can beused by bird watchers, fishing enthusiasts, animalrescue shelters (to match animals to prospectiveowners) to name a few.

4. Relation of Fuzzy Logic and Expert System

A fuzzy expert system is an expert system that uses a collection offuzzy membership functions and rules, instead of Boolean logic, to reason about data. The rules in a fuzzy expert system are usually of a form similar to the following:
if x is low and y is high then z = medium where x and y are input variables (names for known data values), z is anoutput variable (a name for a data value to be computed), low is amembership function (fuzzy subset) defined on x, high is a membershipfunction defined on y, and medium is a membership function defined on z.The antecedent (the rule's premise) describes to what degree the ruleapplies, while the conclusion (the rule's consequent) assigns amembership function to each of one or more output variables. Most tools for working with fuzzy expert systems allow more than one conclusion perrule. The set of rules in a fuzzy expert system is known as the rule base or knowledge base.
The general inference process proceeds in three (or four) steps.

1. Under Fuzzification, the membership functions defined on the input variables are applied to their actual values, to determine the degree of truth for each rule premise.

2. Under Interference, the truth value for the premise of each rule is computed, and applied to the conclusion part of each rule. This result in one fuzzy subset to be assigned to each output variable for each rule. Usually only MIN or PRODUCT is used as inference rules. In MIN inference, the output membership function is clipped off at a height corresponding to the rule premise's computed degree of truth (fuzzy logic AND). In product inferencing, the output membership function isscaled by the rule premise's computed degree of truth.

3. Under Composition, all of the fuzzy subsets assigned to each outputvariable are combined together to form a single fuzzy subset for each output variable. Again, usually MAX or SUM are used. In MAXcomposition, the combined output fuzzy subset is constructed by taking the point wise maximumover all of the fuzzy subsets assigned to variable by the inference rule (fuzzy logic OR). In SUM composition, the combined output fuzzy subset is constructed by taking the point wise sumover all of the fuzzy subsets assigned to the output variable by theInference rule.

4. Finally is the (optional) Defuzzification, which is used when it is useful to convert the fuzzy output set to a crisp number. There aremore defuzzification methods than you can shake a stick at (at least 30). Two of the more common techniques are the CENTROID and MAXIMUM methods. In the centroid method, the crisp value of the output variable is computed by finding the variable value of the center of gravity of the membership function for the fuzzy value. In the MAXIMUM method, oneof the variable values at which the fuzzy subset has its maximum truth value is chosen as the crisp value for the output variable.

5. Architecture of Fuzzy Logic

There are five attributes associated with fuzzy expert systems:

1) Input variables,

2) Output variables,

3) Subsets of the inputs and the outputs and the membership functions corresponding to the various subsets leading to fuzzy set

4) Rules connecting the input fuzzy subsets and the output fuzzy subset

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5) Procedure (or methodology) for de-fuzzification of the output.

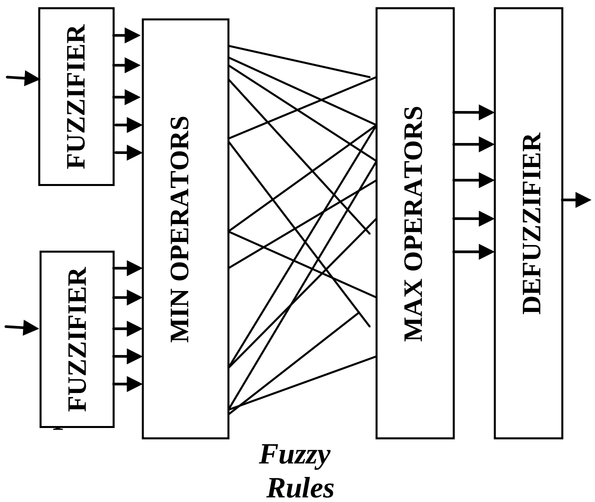

Fig. 3 Block Diagram of Fuzzy System

A. Fuzzification

Fuzzification is supposed to convert the analog inputs into sets of fuzzy variables. For each analoginput, several fuzzy variables are generated with values between 0 and 1. The number of fuzzy variablesdepends on the number of member functions infuzzification process. Various types of memberfunctions can be used for conversion, such as triangular and trapezoidal. One may consider using thecombination of them and different types of membership functions result in different accuracies. One may notice that using triangular membership functions can get better surface than from usingtrapezoidal membership functions.

The more membership functions are used, the higher accuracy will be obtained. However, very densefunctions may lead to frequent controller actions (known as "hunting"), and sometimes this may leadsto system instability; on the other hand, more storage is required, because the size of fuzzy table isincreased exponentially to the number of membership functions.

B. Fuzzy Rules

Fuzzy variables are processed by fuzzy logic rules, with MIN and MAX operators. The fuzzy logic canbe interpreted as the extended Boolean logic. For binary "0" and "1," the MIN and MAX operatorsin the fuzzy logic perform the same calculations as the AND and OR operators in Boolean logic, respectively.

Table 1 Binary Operation Using Boolean Logic and Fuzzy Logic

A	B	A AND B	MIN(A,B)	A OR B	MAX(A,B)
0	0	0	0	0	0
0	1	0	0	1	1
1	0	0	0	1	1
1	1	1	1	1	1

C. Defuzzification

As a result of "MAX of MIN" operations in Mamdani fuzzy systems, a new set of fuzzy variables is generated, which later has to beconverted to an analog output value by defuzzification blocks. In TSK fuzzy systems, thedefuzzification block was replaced with normalization and weighted average; MAX operations are notrequired, instead, a weighted average is applied directly to regions selected by MIN operators.

CONCLUSION

In this paper, we give a systematic introduction to concepts in fuzzy logic as well as neuro-fuzzy systems and Expert System. Fuzzy logic provides effective tools for modeling uncertainty in human reasoning. A fuzzy inference system represents knowledge in IF-THEN rules, and implements fuzzy reasoning. Whereas Expert systems technology is an emerging area which is finding applications in a number of diverse areas. Organizations are employing expert systems to capture the problem-solving skills of human experts to either assist the expert or use them in those situations where the expert is not available. This paper has provided a brief overview of this technology too and has discussed its application in the area of science.Applications of expert systems in the sciences are expected to increase in the near future. Expert system has a wide scope in the development of the medical industry. In future, we can be made work to derived the neuro-fuzzy medical diagnose. This would definitely increase the accuracy to 99.9%, reduce the cost and save time.

REFERENCES

[1] JOHN DURKIN, "Application of Expert Systems in the Sciences "Department of Electrical Engineering, The University of Akron, Akron, OH 44325.1990.
[2]Hilda Ramirez"ESDIABETES (AN EXPERT SYSTEM IN DIABETES)"March 2001,Journal of computer Science
[3]Mario A Garcia, AmitJ.Gandhi, Tinu Singh, Leo Duarte, RuiShen, MaruthiDantu, Steve Ponder.
[4]Rahul Malhotra, Narinder Singh, Yaduvir Singh" Fuzzy Logic Modelling, Simulation and Control: A Review" IJCST Vol. 1, Issue 2, December 2010.
[5]Dr. A.V Senthil Kumar**"** Fuzzy Expert System for Diabetes using Fuzzy Verdict Mechanism" Int. J. Advanced Networking and Applications Volume: 03, Issue: 02, Pages:1128-1134 (2011)

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ISSN (Online) : 2278-1021

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Vol. 2, Issue 3, March 2013

[6] Yasser Abdelhamid, Hesham Hassan, Ahmed Rafea" A Proposed Methodology For Expert System Engineering" Central Laboratory for Agricultural Expert Systems.
[7]Bob Jansen"Two Expert System Applications: Implications for Knowledge Representation for Explanations and Justifications**"**
[8] M.Kalpana, Dr. A.V Senthil Kumar,Design and implementation of Fuzzy Expert System using Fuzzy Assessment Methodology, International Journal of Science and Applied Information Technology,Volume 1, No.1, March – April 2012
[9]Andreja P. Picon,INeli R. S. Ortega,II Ricky Watari,I Cristina Sartor,I Isabel C. N. Sacco*"*Classification of the severity of diabetic neuropathy: a new approach taking uncertainties into account using fuzzy logic"2012(02)10".
[10] Hao Yu Auburn UniversityTiantianXieAuburn UniversityBogdan M. WilamowskiAuburn University "Neurofuzzy System"
[11]Http://year12ipt.ash.com/untitled-6.html