IJIRR

International Journal of Information Research and Review
Vol. 10, Issue, 02, pp.7473-7477, February, 2023

RESEARCH ARTICLE

EXPERT SYSTEM AS MACHINE INTELLIGENCE TECHNIQUES FOR MOBILE LEARNING

*Dr. Ranita Ganguly

Delaware State University, Dover, DE, USA

ARTICLE INFO

Article History:
Received 09th November, 2022
Received in revised form
27th December, 2022
Accepted 19th January, 2023
Published online 28th February, 2023

Keywords:

Fuzzy Logic, Machine Intelligence, Expert System, Mycin, Uav.

ABSTRACT

Expert system is a computer that emulates the decision-making capacity of human experts. This paper highlights the components, the architecture, the role of knowledge base and pattern of knowledge representation in a typical expert system. MYCIN and its components are also analyzed in this paper. Fuzzy logic is a viable and practical form of machine intelligence that has been especially successful in designing expert systems dealing with imprecise data. Majority of the Unmanned Aerial Vehicles (UAVs) in operation today are dependent on a remote human pilot. Higher degree of autonomy provides savings in cost and operational resources and increases safety. However, the challenges involved in making such unique autonomous system, has reasoning and decision-making capabilities analogous to a human pilot. All this is acquired through the developments in fuzzy logic. Fuzzy logic has also penetrated the process of ensuring safety in exploration of crude oil and gas, in detecting the insulation pattern of electronic equipments, monitoring aircraft engine performance and in many such allied fields. The latest developments in expert systems and fuzzy logic have served in generating a billion-dollar business in Mobile learning world by using algorithms for recognizing patterns of learning speed and time. The system then regulates the Mobile learning content by providing needed information to learners. This in turn helps as a tool by teachers to form data driven decisions in response to student needs.

INTRODUCTION

Machine intelligence is the process of making machine, intelligent, so that they can perform well and efficiently in absence of human beings. It is the process of developing computer programs for solving complex problems, by application of processes analogous to the human reasoning process. Machine Intelligence is the analysis and design of computer systems that reflects some form of intelligence. It is like a system that thinks and behaves rationally like human. It can perform tasks like reasoning out and drawing conclusion, processing natural language, explaining, and learning new concepts and tasks. Fuzzy logic is a form of machine intelligence, which can deal with non quantifiable concepts such as “gray”. Though the name sounds colorful, fuzzy logic is a serious business. Software developers can easily program computers using fuzzy logic which can denote uncertainty in terms like “gray” and “sharp” – terms inherent in human reasoning. The concept of “fuzziness” originated from a paper written by Dr. Lotfi Zadeh, published in the year 1965. By the term “fuzziness”, Dr. Zahed meant classes in which there is no sharp transition from membership to non-membership.

*Corresponding author: **Dr. Ranita Ganguly,***
Delaware State University, Dover, DE, USA.

For example, the class of gray objects is a fuzzy set. Dr. Lotfi Zadeh invented a way for computer programs to recognize the shades of gray to imitate the imprecise way that humans make decisions. Machine intelligence and fuzzy logic is now a key to evaluate online exam environments through retinal scan, environment stimulus scanning and IP tracking.

Machine Intelligence – An Overview

Human beings think and behave rationally while machine intelligence imitates the actions and behavior of human beings and their thinking and reasoning process. Process, which is analogous to the human reasoning process, is the distinguishing feature of machine intelligent programs. Human intelligence makes the computers intelligent and automates the activities like decision making, problem solving, learning, and reasoning process so that it can remain within human control. Few vital characteristics of machine intelligent program are that they manipulate symbolic information to a large extent in contrast to the conventional program. Machine intelligent programs have a combinatorial explosion of solution. They are easy to learn, and they deal with real life problems to a large extent. Fuzzy computers offer better performance in addition to being cheaper and easier to build. Fuzzy computers are pre-programmed with highly flexible rules. The fuzzy logic computer must satisfy some real-time constraints, process large volume of data and refer to large knowledge base. An expert system is an intelligent computer program that uses knowledge

and interface procedures for solving complex problems that requires significant human expertise for their solution.

Contradictory terms "fuzzy" and "logic"

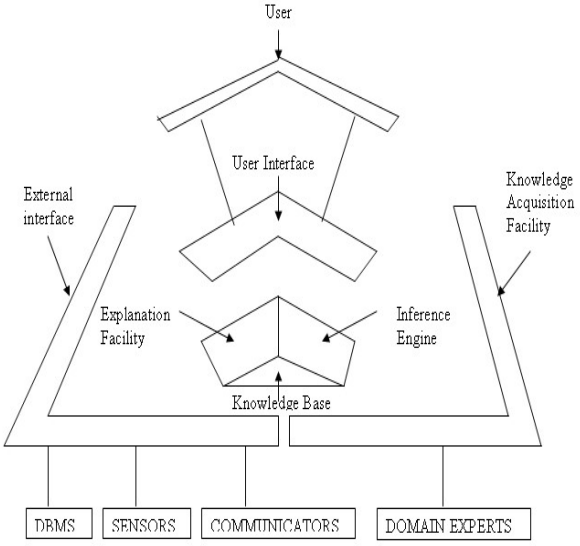
Fuzziness is based on imprecision and is not based on the probability theory. Probability describes things as black and white, while fuzzy logic describes it as shades of gray. Fuzzy logic is not limited to the digital logic of 0 and 1. Fuzzy logic is known as the super set of conventional (Boolean) logic that can be used to calculate intermediate values between absolutely true and absolutely false and is represented as degree of "membership", with truth values ranging between 0 and 1. Unlike Boolean logic, fuzzy logic values can range between 0.0 and 1.0 both inclusive, not just 0 and 1. In defining "young", anyone under 20 and "old" as anyone over 20 years old, even one month older than 20 will be categorized as "old". A fuzzy program can recognize this person as belonging to both groups, but much closer to "young" than "old" and can be represented as *m(YOUNG(person's name)) = 0.11.*

Building blocks of expert systems: Expert system is a branch of machine intelligence. An expert system has two parts: the knowledge base and the inference engine. Knowledge can be defined as a set of known set of facts and figures. Any system becomes effective when the solution methods incorporate domain specific rules and facts. The system becomes an effective problem solver, only when specific knowledge was brought on the problem. Such specific knowledge is called as domain specific knowledge, which leads to the development of knowledge-based system. The meaning of knowledge is closely associated with the meaning of intelligence. Intelligence requires possession and access to knowledge. A common way to represent knowledge for computer or human is in the form of written language. The knowledgebase an expert use is what he has learnt at school, from colleagues, and from years of experience. The knowledge base has factual and heuristic knowledge. Factual knowledge is the knowledge gathered from books, magazines, or journals. Heuristic knowledge is based on experiential and judgmental power of performance. Knowledge requires the use of both data and information. Unlike data, knowledge is processed and organized, e.g., a physician treating a patient uses both data and knowledge. Data is the patient's record like his history, drugs given; response to drugs, different tests etc, whereas knowledge is what the physician has learnt in medical schools and practice. Knowledge is organized collection of data. Knowledge is voluminous, constantly changing and it cannot be characterized.

Examples:

- John is tall ≡ tall(John)This expression is an attribute possessed by a person.
- Bill hates Sue≡hate (Bill, Sue): This expression is a complex binary relation between two persons.
- Sam has learned the use of recursion by implementing linked list in several programming language ≡learn_recursion (Sam, programming_language): This expression represents the relation between person and more abstract programming concept.

Components of expert systems: *Knowledge base* is the core module in any expert system and the warehouse of domain specific knowledge captured from human expert by the knowledge acquisition module facility.



Source: Benn Coppin: Artificial Intelligence Illuminated

Fig.1. Architecture of Expert System

Inference engine/ Rule interpreter performs the task of firing rules. It uses forward and backward chaining method. Firing of rules causes two major things to happen:

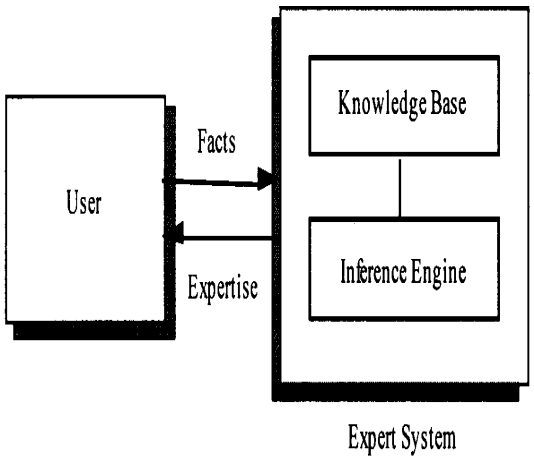
- Trigger another rule, thereby a network of rules are triggered.
- It implies an action has been carried out and this adds new information to the database of inferred facts.

User and User interface helps in interpreting the instructions that the user provides and transforms them to the machine understandable format to fetch information from the knowledge base. Basically, it provides the needed facilities for the user communication with the system. The user can have system consultation for the following aspects.

- To get remedies for the problem.
- To know the private knowledge of the system if the user is a student.
- To get some explanation for specific queries.

Now a days expert system is acquiring the knowledge and performing by the process of 'BEING TOLD'. This is called as *Knowledge Acquisition Facility* (KAF). It is a major drawback in expert system development currently. Expert systems do not have a sophisticated version of learning system. *External interface* provides communication between the external environment and the expert system. When there is a formal condition to be enforced, it is done via user interface. In real time expert system, where they form a part of the closed loop system, it is not proper to expect human intervention every time, to feed in the conditions prevailing and get remedies. The external interface gets minute-by-minute information by using the sensors like the atomic reactors and fighter jet aircrafts. E*xplanation system* of an expert system provides explanation facility. The basic question that the user would like to ask the system is 'Why' and 'How'. The answers of 'How' and 'Why' questions are very important to prove the decisions of an expert system. Students use the 'How' question to ask and experts use the 'Why' question to verify. DENDRAL is an expert system

used in the detection of mines, MYCIN is used in homeopathy, ELIZA is also an expert system, which is used in consultation for conversation between humans and machines.



Source: blue.cs.ksi.edu/dl/demo/index.htm

Fig.2. Basic Concept of an expert system function

Characteristics of an expert system

- ***High level of performance*:** The system must perform at a better level of competency than any expert in that field.
- *Adequate response time:* The system must reach a decision in a reasonable time, which is lesser than the time required by an expert in that field.
- ***Good reliability:*** The expert system must be reliable and not prone to crashes, otherwise it will not be in use.
- ***Understandability:*** The system will be able to explain the steps of its reasoning while executing, so that it is understandable.
- ***Flexibility:*** On account, of the large amount of knowledge an expert system may have. It is important to have 'efficient mechanism' for adding, changing, and deleting the knowledge.
- ***Explanation:*** Human life and property depends on the answers of the expert system, because of the great potential harm it can cause. Therefore, an expert system must be capable of justifying the conclusion.

Advantages of expert systems

- ***Increased availability:*** Due to mass expertise production, experts are available in all types of computer hardware or software.
- ***Increased reliability:*** Expert system corrects and assures the decision made by human experts.
- ***Reduce cost:*** Cost of expertise is made much lower.
- ***Reduced danger:*** Expert system may be used in environments like coalmines or atomic reactors that might be hazardous for all humans.
- ***Permanence:*** Expertise is permanent in nature. The expert system knowledge can last infinitely. The knowledge of multiple experts can be made available to enable us to work simultaneously and to continuously work on a problem at any time day or night.
- *Steady, unemotional, and complete response always available:* The expert system can easily explain in detail the reasoning process that leads to a conclusion when human experts are unwilling to explain.
- *Fast response:* Expert System provides fast response to any user request.

MYCIN as an expert system: MYCIN is an expert system used for diagnosing bacterial disease. MYCIN was developed over five or six years in the early 1970s at the Stanford University to help physicians in identifying bacteria causing the infection and then suggesting remedial solution. The knowledge base of MYCIN is organized as a set of production rules with certainty factor attached to it.

Control structures used are a set of goal directed backward chaining of rules, but one advanced feature is that the ordering of the rule is not essential. MYCIN has explanation system facilities to answer 'How' and 'Why' questions. 'Why' questions can be posed to the system at any point of time during consultation and the system will respond with the action part of the rule. The 'How' question helps in understanding the reasoning process of how the answers were arrived at i.e., the system triggers a list of rules used.

Fuzzy logic developments

The governmental and industrial actions in Japan over the last few decades, clearly indicates that Japanese have fully embraced fuzzy logic. They have found that high accuracy is not required in many applications, where they can use fuzzy logic. Japanese manufacturers are leading the use of fuzzy logic in different range of technologies. Fuzzy logic systems were previously taken as low technology, but in the long run, this evolved as a high technology to be used in rule based expert systems. The rules are elicited from the human experts, using knowledge acquisition system. The Japanese were the first to use the enormous potential of fuzzy logic in many commercial applications. The Japanese have developed fuzzy logic extensively in hardware and software level using fuzzy logic algorithms. An example is "palmtop" computer of Sony, which uses fuzzy logic in recognizing handwriting pattern in computer.

A professor of computer science named Watanabe, at the University of North Carolina, designed a fuzzy chip, which can be applied in the "brains" of mobile robots developed in Oak Ridge National Laboratory, for use in radioactive areas and nuclear power plants. With fuzzy logic, absolute accuracy is not required in specifying file searches and sorts. Using conventional algorithms of search-and-sort, the search will filter out anything that does not match exactly. This problem was solved by fuzzy logic. Overall, fuzzy logic works with less software. Using fuzzy logic, Hitachi Ltd programmed a robot arm using only one-tenth of the software code it would take to do the job digitally. Fuzzy logic cannot replace traditional logic as the use of precise calculations using traditional mathematics cannot be made unnoticed. Using fuzzy logic, the continuous range measures like speed, temperature, and birth rate can easily be represented. A fuzzy expert system would require only few rules than typical expert systems, which require hundreds of rules to represent a real-world situation. The most common fuzzy logic operators used are OR, AND, NOT. The typical way of representing them is given below.

- A OR B = MAX(m(A(x),m(B(x)))
- A AND B = MAX(m(A(x),m(B(x)))
- NOT(A) = 1 - m(A(x)

Source:ljs.academicdirect.org/A11/093108.htm

Fig. 3. Structure of a fuzzy logic model

Commercial applications of fuzzy logic: Fuzzy logic is easy to understand, flexible, tolerant to imprecise data and based on natural language. Fuzzy logic can therefore be built on top of expert system. These characteristics of fuzzy logic has been exploited in household and commercial appliances like dish washers, self-focusing camera, as decision support system, in metrological systems in detecting the weather and also in several expert systems.

Transport: Hitachi Ltd of Tokyo runs subway operations in Japan. This is an automatic train whose speed and halt rate can be precisely regulated and controlled using a simple fuzzy-logic gear, in contrast to a human controlled train. Unlike human drivers, these fuzzy systems are used for rearranging departure schedules, smooth acceleration and also brakes in the train. It optimizes fuel consumption and also improves the system performance. The cost savings are passed as benefits to the customers in terms of smooth ride and low transport fares.

Medicines: The use of fuzzy logic has penetrated in the field of medicine and medical diagnosis. It uses degree of membership to a fuzzy set to represent the intensity of the disease, degree of belief that a patient suffers from this disease. Fuzzy Expert System is now used in a medical information system at the Vienna General Hospital. It is reported to have approximately 93 per cent accuracy, based on an average of 500 test cases. Other medical applications of fuzzy logic are in analysis of chest pain, treatment of diabetes etc. SYNTEX, SPHINX and EXPERT are some expert systems that use fuzzy logic in hospital management, medical diagnosis and rheumatology respectively.

Elevators: Toshiba is selling elevators which uses fuzzy logic control to reduce the waiting time. The system applies expert system and fuzzy logic simultaneously to control a group of elevators. It reduces the waiting time of passengers by 15% to 30%.

Air conditioners: The fuzzy controlled air conditioner balances room temperatures according to the number of people in the room. Mitsubishi Heavy Industries cuts power bills by 24%. The air conditioner cools a room faster if the infrared sensor detects people in the room.

Televisions: The fuzzy logic control systems are used by Japanese television industry like Sony. Fuzzy logic is used to decide the sharpness, brightness, and color of the picture.

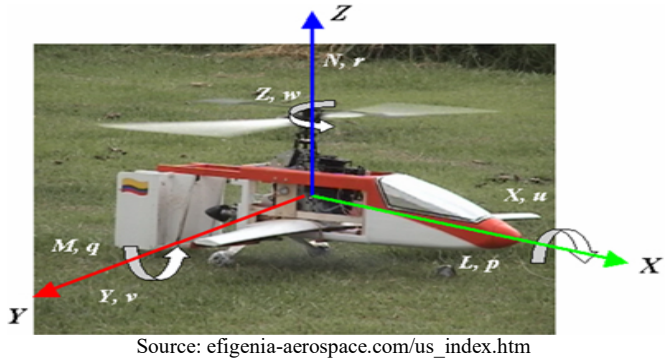
Financial analysis: Stock market analysis for Yamaichi Securities is done by using fuzzy logic control in estimating the performance of shares. First it compares security's risk with the market rate, and then by analyzing the interest rates and other economic factors.

Washing machines: The only control of fuzzy logic-based washing machine is just the push button. The machine uses an optical sensor to analyze the nature of clothes, and decides the quantity of soap, the level of water and the number of cycles needed. This in-built system is comparable to a human's reasoning ability.

Fuzzy Logic for controlling accidents and failures in oil and gas production: Using fuzzy rules, control methods are being designed for the accident prevention and failures in oil and gas exploration. Fault diagnosis in these areas is also possible using fuzzy logic.

Fuzzy logic for Unmanned Aerial Vehicles (UAV) decision making

Pavel Trivailo and a team of engineers at the Royal Melbourne Institute of Technology were exploring to devise a sophisticated air delivery device that will allow them to lift and drop loads and people without any jolt, and would help in complicated maneuvers like speeding up rescues at sea, make cargo or aid delivery far easier, easily reach remote disaster site or war zones and collect injured people from such inaccessible regions of forest or mountain. Unlike helicopters, this air delivery system does not have limited range, velocity and capacity and can fly to high altitudes where the air is thin. Trivailo wanted to develop a sophisticated system that did not depend on human judgment to calculate the precise position of the load at the end of the line, by paying out or reeling in the line automatically.



Source: efigenia-aerospace.com/us_index.htm

Fig.4. Unmanned Aerial Vehicle

He aspired to make the whole process quicker, easier and safer. Trivailo designed a system that can control the winch for adjusting the length of the cable, as the exact values for drag are tough to determine. Trivailo finally resolved to apply fuzzy logic to create a series of rules based on human behavior instead of precise values. The fuzzy logic controller uses feedback collected from sensors that finds the position of the cable end to determine the aircraft's flight path.

The system that this creates can manage the position of the end of the line on a millisecond-by-millisecond basis without damaging the payload.

Fuzzy logic in automated engine health monitoring system (AEHMS): The AEHMS for commercial aircraft was developed using fuzzy logic. The engine performance parameters collected from every flight was taken as input. The fuzzy rule inference system used expert knowledgebase in different kinds of engine faults. The program triggers an alert if any output exceeds a specified value. Now this method is used in monitoring engine conditions of Turkish Airlines. The outcome was that it minimized the extra labor hours, human error, maintenance costs and requirement for engineering expertise. Aircraft health monitoring system is a very popular way to increase aircraft availability.

Current trends of using expert systems in digital learning and assessments

Now days, expert system focuses on very specific topics like computer fonts, protein crystallography, radiology, diagnostic skills etc. Biometrics is the application of statistical method to biological phenomena. It is the measurable, behavioral, or physical feature which is used to verify user identity. It compares the individual physical features with stored biometric reference data for user access authentication. It is normally used to protect access to individual PC, cell phones, pocket sized PC, networks, web servers, database applications and transactions conducted via telephone or internet within the educational campus. Fingerprint identification is the oldest method. The unique fingerprint of user is converted to digital fingerprint template and stored in smart card or central database for authentication purpose of student access in lab, canteen or exam hall. Recently use of expert systems in biometrics alleviates the problem in multiple evidence of biometric identification by combining multi-domain expertise in biometric modalities like fingerprints, voice, retina, facial and hand geometry. Many learners struggle to grasp some concepts from scratch. Therefore, when the content is pre-recorded, they can repeat watching the videos or listening to the audios embedded in mobile apps until understood for their exam preparation. Now Mobile learners can ask as many questions as they want without interrupting the lecturer and get their doubts cleared multiple times as they need with digital learning using machine intelligence technique.

Limitations of using machine intelligence in mobile learning: Natural Language Processing solutions to transform speech into text, enabling voice recognition and translations enables educators to teach digital learners from all over the globe, greatly increasing the potential of e-learning instrument. Using machine translation enables the digital learners to better understand the language, but the progress and development of expert systems are hampered by lack of proper knowledge representation mechanisms and skills. The major reason is the difficulty in extracting knowledge, building, and maintaining large knowledge bases. There is no flexibility for the users to state the problem. The expert systems do not have any commonsense knowledge or common-sense reasoning process. Besides, the construction process of an expert system is a laborious job, requiring a lot of resources. Though some of the expert systems have facilities of knowledge acquisition by directly interacting with the experts, yet for majority of the system, there is a need of knowledge engineers.

Overall Conclusion

Fuzzy logic is a feasible form of machine intelligence that has been successful in developing expert systems that deals with imprecise data. It is currently applied in computer hardware and software to imitate the range and flexibility of the human mind for personalized and adaptive learning using mobile apps. Application of fuzzy expert systems is used as control decision support in many learning organizations. Overall, the latest developments in machine intelligence have served in generating a billion-dollar business for the education industry through E-learning.

REFERENCES

1. Benn Coppin, *Artificial Intelligence Illuminated*, Jones & Bartlett Publishers, 2004he
2. "Basic Concept of an expert system function"- http:// blue.cs.ksi.edu/dl/demo/index.htm
3. "Structure of a fuzzy logic model" www.ljs.academicdirect.org/A11/093108.htm
4. Unmanned Aerial Vehicles" - www.efigenia-aerospace.com/ us_index.htm
5. Flying Circles Around The Helicopter" http://1timothy4-13.com/files/facts/helicopter.html
6. Fuzzy application"- www.fuzzytech.com/e /literature .html
7. Expert Systems" http://www.aaai.org/ AI Topics/html/ expert.html
8. Rich & Knight, *Artificial Intelligence (2nd Edition)*, McGraw-Hill, 1991
9. *P*etroleum and natural gas engineering" - http://www.pe.wvu.edu/research/part3.htm
10. "Expert system - Wikipedia, the free encyclopedia" - http://en.wikipedia.org/wiki/Expert_system "Expert Systems And Artificial Intelligence" - http://www. wtec.org/loyola/kb/c1_s1.htm
11. Machine Learning and AI Use Cases" - https://www. nagarro.com/en/blog/ai-ml-education-real-life-use-cases

****