ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 10, March 2018

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEM

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Abstract: Artificial Intelligence (AI) is the area of computer science focusing on creating machines that can engage on behaviors that humans consider intelligent. The ability to create intelligent machines has intrigued humans since ancient times and today with the advent of the computer and 50 years of research into AI programming techniques, the dream of smart machines is becoming a reality. Researchers are creating systems which can mimic human thought, understand speech, beat the best human chess player, and countless other feats never before possible. The military is applying AI logic to its hi-tech systems, and how in the near future Artificial Intelligence may impact our lives. Expert systems are latest product of Artificial Intelligence. These Expert systems are developed for large number of problems particularly for medical science.

Keywords: Artificial Intelligence, Expert systems, Human mind, Intelligence

I. Introduction of Intelligence

Someone's intelligence is their ability to understand and learn things It is the ability to think and understand instead of doing things by instinct or automatically. Thinking is the activity of using your brain to consider a problem or to create an idea. Artificial Intelligence is neither a ship or electronic device nor a software or programming style. In contrast, it is the business of using computations to make machines act more intelligently or to somehow amplify human intelligence. A program to do something intelligent. It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines. After WWII, a number of people Independently started to work on intelligent machines. The English mathematician Alan Turing may have been the first. in 1947. He also may have been the first to decide that AI was best researched by programming computers rather than by building machines. By the late 1950s, there were many researchers on AI, and most of them were basing their work on programming computers.

II. Goal of AI

The main goal of AI is to understanding and building intelligent entities. The four main approaches to be covered are:

- Systems that think like humans
- Systems that think rationally
- Systems that act like humans
- Systems that act rationally

III. Brains and computers: AI and neural nets

Some people in AI have been impressed by the fact that the mechanisms of brains are very different in detail from those in computers, even though they

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may be doing similar sorts of things (storing, transforming, using information). This has led to the investigation of neural nets partly inspired by ideas about how brains work.

Some artificial neural nets have developed entirely as practical solutions to engineering problems without much concern for accurate modeling of brain mechanisms. More recent work attempts to move towards more and more accurate models of real neurons, which are incredibly complex and varied.

Some people think that it will never be possible to understand and replicate all the important aspects of brain function unless we replace computers with new kinds of machines, or perhaps build hybrid machines using different technologies. This conclusion is premature. There are two reasons: We do not yet know what the real potential of computers will turn out to be as we develop new types which are faster and smaller and can be linked together in vast collections of cooperating systems There is much that we do not know about brains: including what they do and how they do it. So we cannot yet say with confidence that there's ANYTHING brains can do which computers will NEVER be able to do, even though there are many things brains can do which existing computers cannot do (and vice versa).

V. Expert system

An Expert System is a set of programs that manipulate encoded knowledge to solve problems in a specialized domain that normally requires human expertise. The expert's knowledge is obtained from the specialists or other sources of expertise, such as texts, journal articles and databases. Table shows the applications of expert systems in various fields.

Area of Expert systems	%
Engineering & manufacturing	35
Business	29
Medicine	11
Environment & Energy	9
Agriculture	5
Telecommunications	4
Government	4
Law	3
Transportation	1

Table1. Distribution of expert systems over application areas

VI. Architecture of an Expert System

The architecture of Expert system is shown in figure 1.The Explanation of each of the component is given

Below.

A. Knowledge Base

It contains the knowledge necessary for understanding; formulating and solving problems. It includes facts about a specific subject area (called a domain). Facts could include definitions, relationships, measurements, probabilities, observations, constraints, and hypotheses includes rules of thumb (called heuristics) describing the reasoning procedures by which an expert uses facts to arrive at conclusions

B. Inference Engine

The inference machine is the central component of the AI engine design because it sets forth constraints that the other components must meet. The job of the inference machine is to apply knowledge from the knowledge base to the current situation to decide on internal and external actions. The agent's current situation is represented by data structures representing the results of simulated sensors implemented in the interface and contextual information stored in the inference machine's internal memory.

The inference machine must select and execute the knowledge relevant to the current situation. This knowledge specifies external actions, the agent's moves in the game, and internal actions, changes to the inference machine's internal memory, for the machine to perform. The inference machine constantly cycles through a perceive, think, act loop, which is called the decision cycle.

- **Perceive: Accept sensor information from the game**
- **Think: Select and execute relevant knowledge**
- **Act: Execute actions in the game**

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The inference machine influences the structure of the knowledge base by specifying the types of knowledge that can be used and how that knowledge is represented. For example, a reactive inference machine, with no internal memory, would limit the knowledge base to stimulus-response knowledge represented as rules of the form "if X is sensed then do Y." The knowledge base couldn't contain high-level goals because, without any internal memory, the inference machine couldn't remember the current goal across the multiple Decision cycles needed to achieve it. Thus, a feature of the inference machine, the lack of internal memory, effects the knowledge base by limiting the types of knowledge included.

C. Explanation Facility

Expert systems are able to provide some explanation for the conclusions they reach. The explanation component can interactively answer questions like:

- Why was a certain question asked?
- How was a certain conclusion reached?
- Why was a certain alternative rejected?
- What is the plan to reach the solution?

D. Knowledge Acquisition

Knowledge acquisition is the accumulation, transfer, and transformation of problem-solving expertise from a knowledge source to a knowledge base. Potential sources of knowledge include human experts, textbooks, databases, special research reports, and pictures. A knowledge engineer works with experts to capture their knowledge and incorporate it into the knowledge base A typical expert system architecture is shown in Figure .The knowledge base contains the specific domain knowledge that is used by an expert to derive conclusions from facts. In the case of a rule-based expert system, this domain knowledge is expressed in the form of a series of rules.

The explanation system provides information to the user about how the inference engine arrived at its conclusions. This can often be essential, particularly if the advice being given is of a critical nature, such as with a medical diagnosis system. If the system has used faulty reasoning to arrive conclusions, then the user may be able to see this by examining the data given by the explanation system. The fact database contains the case-specific data that is to be used in a particular case to derive a conclusion. In the case of a medical expert system, this would contain information that had been obtained about the patient's condition. The user of the expert system interfaces with it through a user interface, which provides access to the inference engine, the explanation system, and the knowledge-base editor. The inference engine is the part of the system that uses the rules and facts to derive conclusions. The inference engine will use forward chaining, backward chaining, or a combination of the two to make inferences from the data that is available to it.

The knowledge-base editor allows the user to edit the information that is contained in the knowledge base. The knowledge-base editor is not usually made available to the end user of the system but is used by the knowledge engineer or the expert to provide and update the knowledge that is contained within the system.

E. The Expert System Shell

The parts of the expert system that do not contain domain-specific or case-specific information are contained within the expert system shell. This shell is a general toolkit that can be used to build a number of different expert systems, depending on which knowledge base is added to the shell. An example of such a shell is CLIPS (C Language Integrated Production System), other examples in common use include OPS5, ART, JESS, and Eclipse.

F. The Rete Algorithm

One potential problem with expert systems is the number of comparisons that need to be made between rules and facts in the database. In some cases, where there are hundreds or even thousands of rules, running comparisons against each rule can be impractical. The Rete Algorithm is an efficient method for solving this problem and is used by a number of expert system tools, including OPS5 and

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Eclipse. The Rete is a directed, acyclic, rooted graph (or a search tree). Each path from the root node to a leaf in the tree represents the left-hand side of a rule. Each node stores details of which facts have been matched by the rules at that point in the path. As facts are changed, the new facts are propagated through the Rete from the root node to the leaves, changing the information stored at nodes appropriately. This could mean adding a new fact, or changing information about an old fact, or deleting an old fact. In this way, the system only needs to test each new fact against the rules, and only against those rules to which the new fact is relevant, instead of checking each fact against each rule. The Rete algorithm depends on the principle that in general, when using forward chaining in expert systems, the values of objects change relatively infrequently, meaning that relatively few changes need to be made to the Rete. In such cases, the Rete algorithm can provide a significant improvement in performance over other methods, although it is less efficient in cases where objects are continually changing.

G. Knowledge Engineering

Knowledge engineering is a vital part of the development of any expert system. The knowledge engineer does not need to have expert domain knowledge but does need to know how to convert such expertise into the rules that the system will use, preferably in an efficient manner. Hence, the knowledge engineer's main task is communicating with the expert, in order to understand fully how the expert goes about evaluating evidence and what methods he or she uses to derive conclusions. Having built up a good understanding of the rules the expert uses to draw conclusions, the knowledge engineer must encode these rules in the expert system shell language that is being used for the task. In some cases, the knowledge engineer will have freedom to choose the most appropriate expert system shell for the task. In other cases, this decision will have already been made, and the knowledge engineer must work with what he is given. Steps of Knowledge engineering are given below.

• **Acquisition**

– Acquiring knowledge from human experts, books, documents (Typically in the form of facts & rules)

• **Validation**

– Using test cases to verify quality of knowledge acquired

• Representation

– Organizing the acquired knowledge into a Knowledge Base

• **Inferencing**

– Developing the software to enable inferences to be made using the Acquired knowledge

• **Explanation & Justification**

– Giving user access to the knowledge - typically via:

○ **WHY information is required from the user**

○ **HOW a particular conclusion was reached**

VII. Fuzzy Expert Systems

A. Fuzzy Logic

Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth -- truth-values between "completely true" and "completely false". Dr.Lotfi Zadeh of UC/Berkeley introduced it in the 1960's as a means to model the uncertainty of natural language. Zadeh says that rather than regarding fuzzy theory as a single theory, we should regard the process of fuzzification' as a methodology to generalize ANY specific theory from a crisp (discrete) to a continuous
(Fuzzy) form.

B. What is a Fuzzy Expert System?

A fuzzy expert system is an expert system that uses fuzzy logic instead of Boolean logic. In other words, a fuzzy expert system is a collection of membership functions and rules that are used to reason about data. Unlike conventional expert systems, which are mainly symbolic reasoning engines, fuzzy expert systems are oriented toward numerical processing. 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 know data values), z is an output variable (a name for a data value to be computed), low is a membership function (fuzzy subset) defined on x, high is a membership function defined on y, and medium is a membership function defined on z. The part of the rule between the "if" and "then" is the rule's premise or antecedent. This is a fuzzy logic expression that describes to what degree the rule is applicable. The part of the rule following the "then" is the rule's conclusion or consequent. This part of the rule assigns a membership function to each of one or more output variables. Most tools for working with fuzzy expert systems allow more than one conclusion per rule. A typical fuzzy expert system has more than one rule. The entire group of rules is collectively known as a rule base or knowledge base.

C. The Inference Process

With the definition of the rules and membership functions in hand, we now need to know how to apply this knowledge to specific values of the input variables to compute the values of the output variables. This process is referred to as inferencing. In a fuzzy expert system, the inference process is a combination of four subprocesses: fuzzification, inference, composition, and defuzzification. The defuzzification subprocess is optional. For the sake of example in the following discussion, assume that the variables x, y, and z all take on values in the interval [0, 10], and that we have the following membership functions and rules defined.

Low(t) = 1 - t / 10
High(t) = t / 10
Rule 1: if x is low and y is low then z is high
Rule 2: if x is low and y is high then z is low
Rule 3: if x is high and y is low then z is low
Rule 4: if x is high and y is high then z is high

Notice that instead of assigning a single value to the output variable z, each rule assigns an entire fuzzy subset (low or high). In this example, low (t)+high (t)=1.0 for all t. This is not required, but it is fairly common. The value of t at which low (t) is maximum is the same as the value of t at which high(t) is minimum, and vice-versa. This is also not required, but fairly common. The same membership functions are used for all variables.

D. Where are Fuzzy Expert Systems Used?

To date, fuzzy expert systems are the most common use of fuzzy logic. They are used in several wide-ranging fields, including:

- Linear and nonlinear control.
- Pattern recognition.
- Financial systems.

VIII. MYCIN (Example of Available Expert Systems)

One of the most important expert systems developed was MYCIN.This is a system which diagnoses and treats bacterial infections of the blood. The name comes from the fact that most of the drugs used in the treatment of bacterial infections are called: Something mycin MYCIN is intended to be used by a doctor, to provide advice when treating a patient. The idea is that MYCIN can extend the expertise of the doctor in some specific area.

Rules in MYCIN are of the form:

IF
1. The gram stain of the organism is gramneg, and
. The morphology of the organism is rod, and
. The aerobicity of the organism is anaerobic
THEN
There is suggestive evidence that the identity of the organism is bacteroides.

An example of a rule with OR conditions are:

IF
1. The therapy under consideration is:
Cephalothin, or Clindamycin, or erythromycin, or Lincomycin, or Vancomycin
And
2. Meningitis is a diagnosis for the patient
THEN
It is definite that the therapy under consideration Is not a potential therapy?

Working of the MYCIN

MYCIN has a four-stage task:

- Decide which organisms, if any, are causing significant Disease.
- Determine the likely identity of the significant organisms.

- Decide which drugs are potentially useful.
- Select the best drug, or set of drugs.
- The control strategy for doing this is coded as meta-knowledge.

So MYCIN starts by trying to apply the control rule, and this generates *sub-goal*s. The first of these is to determine if there is an organism, which needs to be treated. This generates another sub-goal; whether the organism is Significant. This provokes a question to the user. The answer allows other rules to be fired, and these lead to further questions. Eventually the IF part of the control rule is satisfied, and the THEN part compiles a list of drugs, and chooses from it.

A consultation with MYCIN

MYCIN chains back from its overall goal of deciding what organisms need treatment until it finds it lacks information, and then asks the user for it. Using MYCIN is thus an interactive process:

- MYCIN starts running.
- MYCIN asks a question.
- The user answers it.
- MYCIN asks another question.

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