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Overview of Artificial Intelligence

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Abstract— The face of science and engineering has been changing with the recent growth in computer architecture. This growth is so important and robust that it is dramatically reshaping relationships among people and organizations and providing a foundation for understanding and learning of intelligent behavior in living and engineered systems. Is this growth beneficial to our society, these are such questions of the general public which are due to the lack of education concerning rapidly advancing technologies. This paper attempts to present an overview of Artificial Intelligence (AI). A generally accepted theory that "machine will do and think like humans more in the future" is the concept behind AI. Brief literature of different aspects by which AI is achieved like expert system, knowledge based systems (knowledge engineering), neural networks, fuzzy logic, Neuro-fuzzy logic and fuzzy expert system, is included in order to have a clear understanding of AI. Along with this the different applications of AI, has been included in this paper. It is concluded that extensive ongoing research in the field of AI gives an idea that in near future a day will come when human beings and machines will merge into cyborgs or cybernetic organisms that are more capable and powerful than either. This idea is called transhumanism.

Keywords- Artificial Intelligence; Expert System; Neural Network; Fuzzy Logic; Neuro-fuzzy logic.

I. INTRODUCTION

Artificial Intelligence term was coined by John McCarthy in 1956. He defined it as "the science and engineering of making intelligent machines." AI is the branch of computer science which deals with the study and design of intelligent agents that perceives its environment and takes actions which maximize its chances of success. AI may be defined as: "The ability to hold two different ideas in mind at the same time and still remain the ability to function". But AI must include the learning from past experience, reasoning for the decision making, inference power and quick response. Also it must be able to take decisions on the basis of priorities and tackle complexity and ambiguity. Machines programmed to carry out tasks, when carried out by humans would require intelligence, are said to possess artificial intelligence. AI's scientific goal is to understand intelligence by building computer programs that exhibit intelligent behavior by using symbolic inference, or reasoning inside the machine. AI definition is not time-independent. It gives the judgment of any system by keeping time in mind.

II. FEATURES OF AI PROGRAMMING

According to [3] ordinary programming languages don't have the abilities to deal with qualitative information. So, the AI machines are programmed to work with their own developed programming language to manipulate knowledge more effectively. AI programs are different from ordinary programming languages. They are written to manipulate predominantly qualitative rather than numeric information. They use declarative knowledge, i.e. assertions whose truth-value is independent of the algorithmic context. They can induce, deduct and sometimes guess data. They can reconsider decisions by employing back tracking for solutions.

III. COMPONENTS OF AI

AI has four main components

- Expert systems
- Heuristic problem solving
- Natural Language Processing Vision

Expert system handles the situation as an expert and gives performance. Heuristic problem solving is meant to evaluate small range of solutions, may involve some guesswork to find

near optimal solution. Natural language processing provides communication between human and machine in natural language. Vision is the ability to recognize shapes and features etc. automatically.

IV. EXPERT SYSTEM

An expert system is a machine system in which useful human knowledge is added in machine memory in order to give intelligent advice and offer explanations and justifications of its decisions or demand. Expert system relies on a large database of well defined specialized knowledge about a particular area. Construction of such programs is referred to as Knowledge Engineering. All such AI programs that achieve expert-level competence in solving problems in task areas by using knowledge about specific tasks are called knowledge-based Systems or expert systems. These programs contain the knowledge used by human experts, in contrast to knowledge gathered from textbooks. Because of this expert systems are like human experts e.g. doctors, engineers, analysts, teachers, geologists etc which encapsulate the skills of an expert and to dispense advice to less knowledgeable users. This transfer of knowledge depends upon the task and will take place gradually through many interactions between expert and the system .It is easier to build expert system than ones with common sense. They represent task domain. Task means some goal-oriented, problem-solving activity and domain refers to the area within which the task is being performed. One of the earliest expert system MACSYMA which performed a variety of symbolic mathematical tasks was composed of a set of fairly unstructured LISP functions. There are many expert systems exists which have been designed for giving expertise training, designing and trouble-shooting etc. like MYCIN, TURNX, PROSPECTOR. The expert systems are still in their infancy.

A. Benefits of Expert Systems

Following are the benefits of expert system:-

Expert systems have proved to do a better job than humans. They make fewer mistakes and more consistent in their recommendations.

- Artificial Expertise is usually cheaper compared to human expertise.
- They achieved a notable success in the field of training, to train non-experts and even to improve expertise of expert.
- They can handle the mechanical type of repetitive tasks of experts, so that experts can well concentrate on their unique skills in given domain.
- They are compatible with many manager's decision styles.
- They can enable operations in environment not suitable for humans.
- They improve the productivity of industry.

V. FUZZY LOGIC

It was introduced by Dr. Lotfi Zadeh of UC/Berkeley known as father of fuzzy set theory, in the 1960's as a means to model the uncertainty of natural language. Lofti A. Zadeh. Fuzzy Logic are used as a profitable tool to control the subway systems, complex industrial processes, entertainment electronics, diagnosis systems and household appliances e.g. in washing machines fuzzy logic sense load size and detergent concentration and adjust their wash cycles automatically. Fuzzy logic is very useful in manufacturing processes as it can handle situations that cannot be adequately handled by traditional true/false logic. Fuzzy Logic was invented in the United States and rapid growth of this technology has started from Japan. Fuzzy logic is a mathematical approach to problem solving. It is very powerful method of reasoning when there is no simple mathematical model and input data are imprecise for very complex processes and highly nonlinear processes. It produces exact results from imprecise data, and is especially useful in computers and electronic applications. Fuzzy logic differs from classical logic in that statements are no longer true or false, on or off. In traditional logic an object takes on a value of either zero or one but in fuzzy logic, an object can assume any real value between 0 and 1. The human brain can reason with uncertainties and judgments. Computers can only manipulate precise valuations. Fuzzy logic is an attempt to combine the two techniques." Fuzzy logic performs better when compared to conventional control mechanism like PID. According to [4] Fuzzy Logic is only a small part of the logics available to AI. Fuzzy Logic is basically a multi-valued logic derived from fuzzy set theory to deal with reasoning that is approximate rather than precise. Intermediate values between conventional evaluations like yes/no, true/false, black/white, etc. can be formulated mathematically and processed by computers. In this way an attempt is made to apply a more human-like way of thinking in the programming of computers.

A. Fuzzy Expert System

A fuzzy expert system 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. Fuzzy expert systems are oriented toward numerical processing whereas conventional expert systems are mainly symbolic reasoning engines. 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 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. 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. Fuzzy expert systems can have more than one conclusion per rule and can also have more than one rule. The group of rules is collectively known as knowledge base. The Fuzzy expert

system consists of some main stages shown in "fig1": fuzzy, rule execution and de-fuzzy operations [6].

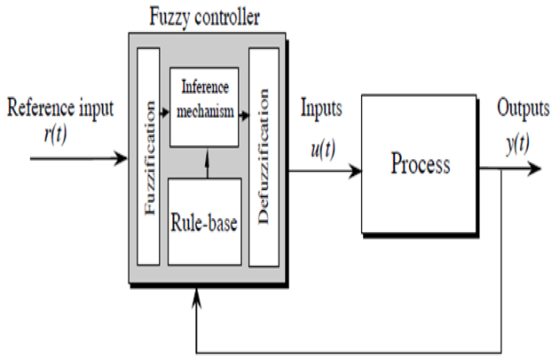

Figure 1: General model of fuzzy expert system

- The "rule-base" shown in "fig3" holds the knowledge, in the form of a set of rules, of how best to control the system.
- The inference mechanism evaluates which control rules are relevant at the current time and then decides what the input to the plant should be.
- The fuzzification interface simply modifies the inputs so that they can be interpreted and compared to the rules in the rule-base.
- The defuzzification interface converts the conclusions reached by the inference mechanism into the inputs to the plant.

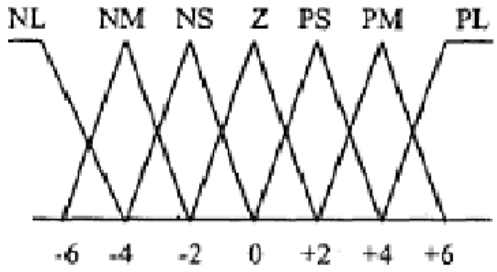

Figure 2: Shape of membership function for fuzzy logic

e	e_c						
	NB	NM	NS	ZE	PS	PM	PB
NB	PB	PB	PM	PM	PS	PS	NM
NM	PB	PB	PM	PS	PS	ZE	NM
NS	PB	PM	PS	PS	ZE	NS	NB
ZE	PB	PS	PS	ZE	NS	NS	NB
PS	PB	PS	ZE	NS	NS	NM	NB
PM	PM	ZE	NS	NS	NS	NM	NB
PB	PM	NS	NS	NM	NM	NB	NB

Figure 3: The Fuzzy linguistic rule table

B. Neuro-fuzzy Logic

Human abilities in controlling the complex systems, has encouraged scientists to pattern from human neural network and decision making systems. Firstly the researches began in two separate fields and resulted in establishment of the fuzzy systems and artificial neural networks. There are primarily three concepts prevailing over the intelligent control:

- Fuzzy Logic Control
- Neural Network based Control
- Neuro-Fuzzy Control (Hybrid Control)

In the first concept, the controller is represented as a set of rules, which accepts/gives the inputs/outputs in the form of linguistic variables. The main advantages of such a controller are:

- Approximate knowledge of plant is required.
- Knowledge representation and inference is simple.
- Implementation is fairly easy

A Neuro controller (neural networks based control system) performs a specific form of the adaptive control with the controller taking the form of a multi layer network and the adaptable parameters being defined as weights. The main its advantages are:

- Parallel architecture
- Any kind of nonlinear mapping is possible
- Training is possible for various operating conditions.

So it can be adapted to any desired situation.

The simple fuzzy controller represents a good nonlinear controller; however, it cannot adapt its structure whenever situation demands. Sometimes the fuzzy controllers with fix structures fail to stabilize the plant under wide variations in the operating conditions. These types of controllers also lack the

parallelism of neural controllers. On the other hand the neural networks are very much adaptive to situations by adjusting their weights accordingly. The parallel architecture enables faster implementation of the control algorithm. However in the presence of noise and other uncertainties the performance may deteriorate. Some times in certain neural controller structures the model of the plant is required. But in case of plants whose model becomes uncertain it is difficult to use neural networks with fixed structures.

VI. ARTIFICIAL NEURAL NETWORKS (ANN)

The concept of a neural network appears to have first been proposed by Alan Turing in his 1948 paper "Intelligent Machinery". Artificial neurons were first proposed in 1943 by Warren McCulloch, a neurophysiologist, and Walter Pitts, an MIT logician. Computers can be operated in nanoseconds, and work without error [7]. But it can't do walking, talking and reasoning like human being. ANN are an attempt to emulate (very roughly) the basic functions of the humans brain to perform complex functions that everyday computer systems are incapable of doing. The human brain is a naturally occurring model of neural network. So, idea is to simulate functioning of the brain directly on a computer and thus develop artificial neurons. Neural Networks are not meant to duplicate the human brain, but to receive information about how the brain works. An ANN involves a network of simple processing elements (artificial neurons) which can exhibit complex global behavior, determined by the connections between the processing elements and element parameters whereas Biological neural networks are made up of real biological neurons that are connected or functionally related in the peripheral nervous system or the central nervous system. In a neural network model a large number of very simple neurons like nodes of processing elements are connected together with a large number of weighted connections between these elements which are highly parallel and distributed. Neurons are extremely slow operating in milliseconds and yet humans can perform extremely complex tasks in just a tenth of a second because brain contains a huge number of processing elements that act in parallel. According to [3]ANN are used to solve artificial intelligence problems by using algorithms designed to alter the strength of the connections in the network to produce a desired signal flow. ANN can recognize something it has never seen before and predict the future, by extracting patterns in the past. Application areas of ANN also include the system identification and control (vehicle control ,process control), function approximation or regression analysis, time series prediction, modeling game playing, sequential decision making (chess, racing),pattern recognition (radar systems, face identification ,object recognition, etc.), sequence recognition (gesture, speech, handwritten text recognition), medical diagnosis, financial applications, data processing (including filtering, clustering), knowledge discovery in databases (KDD), visualization and e-mail spam filtering[7]

VII. APPLICATION OF AI

- To design and analyze the mechanical elements on basis of size limitations.
- To diagnose electronics locomotion systems.
- Can be used in electronics and electrochemical systems.
- To diagnose the software development process.
- To identify chemical compound structures and chemical compounds.
- Can be used in medical diagnosis
- To plan experiments in biology, chemistry and molecular genetics.
- To make stock and bond portfolio for selection and management.
- Trouble shooting systems
- To plan and explore the space.
- To forecast crop damage
- To develop completely automated plants and industries.

VIII. CONCLUSION

Till now AI has not such a great effect directly on common people life and is limited to some areas like military, space, industry, medical, neutral networks and geological. It may be expected that at the end of 2035 with the extensive research and advancement in the field of AI, we will be able to move away from today's machinery that necessarily come with weighty manuals regarding machine languages and develop the machinery which will be able to understand human completely. We will have robot as doctor in hospitals, professor in class room, driver in bus. According to [2] that will be the era of transhumanism where human beings and machines will merge into cyborgs or cybernetic organisms that are more capable and powerful than either.

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