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Application of Artificial Intelligence in Electrical Engineering

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Abstract

This paper starts by recognizing a distinction between mind and cognition, and by positing that cognition is an aspect of mind and propose this as a working hypothesis a Separability Hypothesis which posits that¬¬ can factor off architecture for cognition from a more general architecture for mind, thus avoiding a number of philosophical objections that have been raised about the "Strong AI" hypothesis. Thus the search for an architectural level which will explain all the interesting phenomena of cognition is likely to be futile. Computer-aided engineering has been applied to heavy current electrical engineering, embracing mainly the areas of electric power systems and electrical machines and drives, is used to demonstrate the potential for the application of artificial intelligence in these areas. There are a number of levels which interact, unlike in the computer model, and this interaction makes explanation of even relatively simple cognitive phenomena in terms of one level quite incomplete. Due to artificial intelligence techniques are permanent and consistent and the ability of ease documentation and reproduction this features can impart in development of new technologies in high tension power supplies and in other fields of electrical engineering.
Keyword- Artificial Intelligence (AI), Neural Network, Electrical Engineering

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I. INTRODUCTION

All Artificial intelligence (AI) is the intelligence of machines and the branch of computer science that aims to create it. Textbooks define the field as "the study and design of intelligent agents," where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. John McCarthy, who coined the term in 1956, defines it as "the science and engineering of making intelligent machines"[1]. The field was founded on the claim that a central property of humans, intelligence—the sapience of Homo sapiens—can be so precisely described that it can be simulated by a machine. This raises philosophical issues about the nature of the mind and limits of scientific hubris, issues which have been addressed by myth, fiction and philosophy since antiquity. Artificial intelligence has been the subject of optimism, but has also suffered setbacks and, today, has become an essential part of the technology industry, providing the heavy lifting for many of the most difficult problems in computer science. AI research is highly technical and specialized, deeply divided into subfields that often fail to communicate with each other. Subfields have grown up around particular institutions, the work of individual researchers, the solution of specific problems, longstanding differences of opinion about how AI should be done and the application of widely differing tools. The central problems of AI include such traits as reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects. General intelligence (or "strong AI") is still a long-term goal of (some) research. Application of AI in electrical engineering can be the solution to incompetence in finding faults other than macroscopic level which humans can't find.

II. ARTIFICIAL INTELLIGENCE

Artificial intelligence concerns itself with intelligent Behavior -- the things that make us seem intelligent. In an ultimate view, engineers are about re-creating a perception of man and building a machine using the human framework [5]. This is a strong statement, but describes the underlying current of this work. In 1981, Professor Marvin Minsky, at MIT, in a casual conversation with me, described how people often explore through artificial intelligence their own weaknesses and concerns. He gave real life examples: a man that is color blind studies, computer vision; a person with a speech impediment builds equipment that talks. He then ended with a joke, asking what he could say of me, being interested in thinking. Professor Minsky's observation highlights the inner desires of many who work in the field, and sheds light on true human intentions. Problems arise from human's ignorance of thinking, learning and intelligence. It is difficult to define what is not known. This paper contrast, intelligent Behavior to a stupor, arguing one is the exclusive opposite of the other. By comparing what illustrates the intelligent Behavior to what appears dull, insensible or lethargic, and decipher meaning from the rhetoric.

Finally, as you will read, the definition includes words such as life, spirit and sensitivity. These are direct challenges to man's emotional and primal self. The forces that drive, determination and the will to survive are as much a part of man's intellectual Behavior as creating and reasoning. No definition should exclude this view. "Artificial intelligence is the study of ideas to bring into being machines that respond to stimulation consistent with traditional responses from humans, given the human capacity for contemplation, judgment and intention. Each such machine should engage in critical appraisal and selection of differing opinions within it. Produced by human skill and labor, these machines should conduct themselves in agreement with life, spirit and sensitivity, though in reality, they are imitations."[2] Perhaps the validity of this definition can only be determined by time. When we, or those who follow us, are near to producing the ultimate such machine, one that intelligently responds to real world stimulations comparable to humans.[6] Then, humans can reflect on what was done and best define it.

III. PROBLEMS

The general problem of simulating (or creating) intelligence has been broken down into a number of specific sub-problems. These consist of particular traits or capabilities that researchers would like an intelligent system to display. The traits described below have received the most attention.

A. Deduction, Reasoning, Problem Solving

Early AI researchers developed algorithms that imitated the step-by-step reasoning that humans use when they solve puzzles, play board games or make logical deductions. By the late 1980s and '90s, AI research had also developed highly successful methods for dealing with uncertain or incomplete information, employing concepts from probability and economics. For difficult problems, most of these algorithms can require enormous computational resources — most experience a "combinatorial explosion": the amount of memory or computer time required becomes astronomical when the problem goes beyond a certain size. The search for more efficient problem solving algorithms is a high priority for AI research. Human beings solve most of their problems using fast, intuitive judgments rather than the conscious, step-by-step deduction that early AI research was able to model. AI has made some progress at imitating this kind of "sub-symbolic" problem solving: embodied agent approaches emphasize the importance of sensorimotor skills to higher reasoning; neural net research attempts to simulate the structures inside human and animal brains that gives rise to this skill.

IV. ARCHITECTURES FOR INTELLIGENCE

This paper now moves to a discussion of architectural proposals within the information processing perspective. The main goal is to try to place the multiplicity of proposals into perspective. As this paper review various proposals, and will present some judgments of some relevant issues.

A. Sub-Symbolic

During the 1960s, symbolic approaches had achieved great success at simulating high-level thinking in small demonstration programs. Approaches based on cybernetics or neural networks were abandoned or pushed into the background By the 1980s, however, progress in symbolic AI seemed to stall and many believed that symbolic systems would never be able to imitate all the processes of human cognition, especially perception, robotics, learning and pattern recognition. A number of researchers began to look into "sub-symbolic" approaches to specific AI problems.

B. Bottom-up, Embodied, Situated, Behavior-based or Nouvelle AI

Researchers from the related field of robotics, such as Rodney Brooks, rejected symbolic AI and focused on the basic engineering problems that would allow robots to move and survive Their work revived the non-symbolic viewpoint of the early cybernetics researchers of the 50s and reintroduced the use of control theory in AI. These approaches are also conceptually related to the embodied mind thesis.

C. Computational Intelligence

Interest in neural networks and "connectionism" was revived by David Rumelhart and others in the middle 1980s. These and other sub-symbolic approaches, such as fuzzy systems and evolutionary computation, are now studied collectively by the emerging discipline of computational intelligence.

D. Learning

Machine learning has been central to AI research from the beginning. Unsupervised learning is the ability to find patterns in a stream of input. Supervised learning includes both classification and numerical regression. Classification is used to determine what category something belongs in, after seeing a number of examples of things from several categories. Regression takes a set of numerical input/output examples and attempts to discover a continuous function that would generate the outputs from the inputs. In reinforcement learning the agent is rewarded for good responses and punished for bad ones. These can be analyzed in terms of decision theory, using concepts like utility. The mathematical analysis of machine learning algorithms and their performance is a branch of theoretical computer science known as computational learning theory.

E. Neural Networks

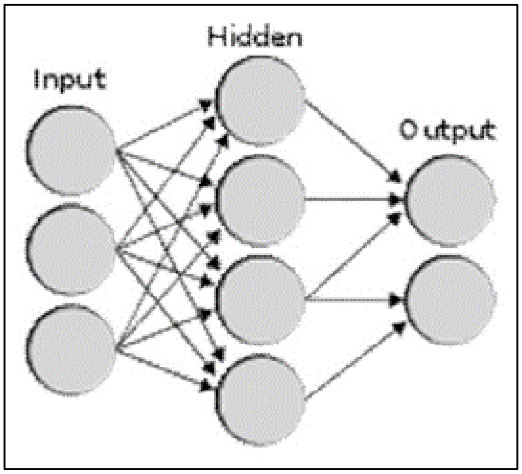

Fig. 1: neural network is an interconnected group of nodes, akin to the vast network of neurons in the human brain

The study of artificial neural networks began in the decade before the field AI research was founded, in the work of Walter Pitts and Warren McCullough. Other important early researchers were Frank Rosenblatt, who invented the perceptron and Paul Werbos who developed the back propagation algorithm. The main categories of networks are acyclic or feed forward neural networks (where the signal passes in only one direction) and recurrent neural networks (which allow feedback). Among the most popular feed forward networks are perceptrons, multi-layer perceptrons and radial basis networks. Amongst recurrent networks, the most famous is the Hopfield net, a form of attractor network, which was first described by John Hopfield in 1982 Neural networks can be applied to the problem of intelligent control (for robotics) or learning, using such techniques as Hebbian learning and competitive learning. Jeff Hawkins argues that research in neural networks has stalled because it has failed to model the essential properties of the neocortex, and has suggested a model (Hierarchical Temporal Memory) that is based on neurological research. [3]

F. Motion and Manipulation

Fig. 2: ASIMO uses sensors and intelligent algorithms to avoid obstacles and navigate stairs. Main article: Robotics

The field of robotics is closely related to AI. Intelligence is required for robots to be able to handle such tasks as object manipulation and navigation, with sub-problems of localization (knowing where you are), mapping (learning what is around you) and motion planning (figuring out how to get there).

G. Control Theory

Control theory, the grandchild of cybernetics, has many important applications, especially in robotics.

H. Social Intelligence

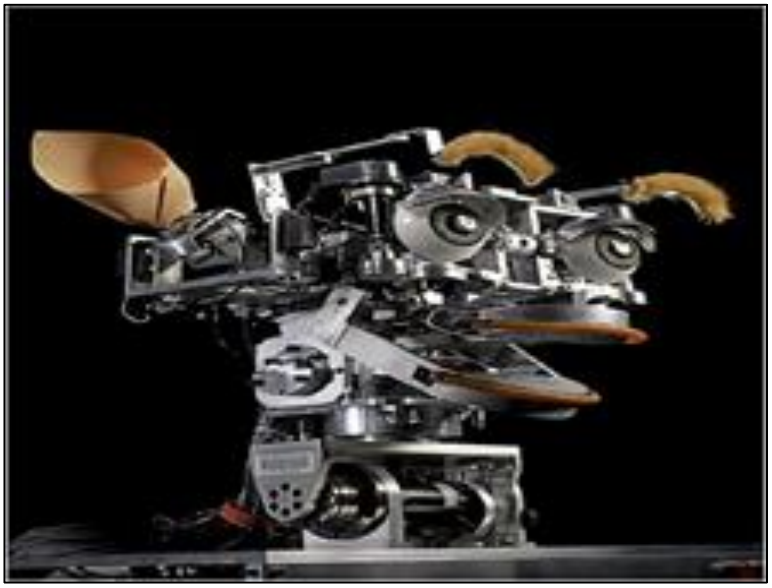

Fig. 3: Kismet, a robot with rudimentary social skills Emotion and social skills play two roles for an intelligent agent

First, it must be able to predict the actions of others, by understanding their motives and emotional states. (This involves elements of game theory, decision theory, as well as the ability to model human emotions and the perceptual skills to detect emotions.) Also, for good human-computer interaction, an intelligent machine also needs to display emotions. At the very least it must appear polite and sensitive to the humans it interacts with. At best, it should have normal emotions itself.

I. Languages

Main article: List of programming languages for artificial intelligence
AI researchers have developed several specialized languages for AI research, including Lisp and Prolog.

J. Creativity

Fig. 4: TOPIO, a robot that can play table tennis, developed by TOSY

A sub-field of AI addresses creativity both theoretically (from a philosophical and psychological perspective) and practically (via specific implementations of systems that generate outputs that can be considered creative). A related area of computational research is Artificial Intuition and Artificial Imagination.

K. Statistical

In the 1990s, AI researchers developed sophisticated mathematical tools to solve specific sub problems. These tools are truly scientific, in the sense that their results are both measurable and verifiable, and they have been responsible for many of AI's recent successes. The shared mathematical language has also permitted a high level of collaboration with more established fields (like mathematics, economics or operations research). Stuart Russell and Peter Norvig describe this movement as nothing less than a "revolution" and "the victory of the neats."

L. Current Application of AI in Power Systems

Several problems in power systems cannot be solved by conventional techniques are based on several requirements which may not feasible all the time. In these situations, artificial intelligence techniques are the obvious and the only option. Areas of application of AI in power systems are:

Operation of power system like unit commitment, hydro-thermal coordination, economic dispatch, congestion management, maintenance scheduling, state estimation, load and power flow. Planning of power system like generation expansion planning, power system reliability, transmission expansion planning, reactive power planning. Control of power system like voltage control, stability control, power flow control, load frequency control. Control of power plants like fuel cell power plant control, thermal power plant control. Control of network like location, sizing and control of FACTS devices. Electricity markets like strategies for bidding, analysis of electricity markets.

Automation of power system like restoration, management, fault diagnosis, network security. Applications of distribution system like planning and operation of distribution system, demand side response and demand side management, operation and control of smart grids, network reconfiguration.

Applications of distributed generation like distributed generation planning, solar photovoltaic power plant control, wind turbine plant control and renewable energy resources. Forecasting application like short term and long term load forecasting, electricity market forecasting, solar power forecasting, wind power forecasting.

V. APPLICATIONS

A. Application in Electrical Engineering

Many areas of applications in power systems match the abilities of expert systems like decision making, archiving knowledge, and solving problems by reasoning, heuristics and judgment. Expert systems are especially useful for these problems when a large amount of data and information must be processed in a short period of time.

1) How Expert Systems can be used in Power Systems

Since expert systems are basically computer programs, the process of writing codes for these programs is simpler than actually calculating and estimating the value of parameters used in generation, transmission and distribution. Any modifications even after design can be easily done because they are computer programs. Virtually, estimation of these values can be done and further research for increasing the efficiency of the process can be also performed.

2) How Genetic Algorithms can be used in Power Systems

1) Planning – Wind turbine positioning, reactive power optimization, network feeder routing, and capacitor placement.
2) Operation – Hydro-thermal plant coordination, maintenance scheduling, loss minimization, load management, control of FACTS.
3) Analysis – Harmonic distortion reduction, filter design, load frequency control, load flow. As genetic algorithms are based on the principle of survival of fittest, several methods for increasing the efficiency of power system processes and increasing power output can be proposed. Out of these methods, using genetic algorithms, the best method which withstands all constraints can be selected as it is the best method among the proposed methods (survival of fittest).

3) Practical Application of AI Systems in Transmission Line

Consider a practical transmission line. If any fault occurs in the transmission line, the fault detector detects the fault and feeds it to the fuzzy system.[4] Only three line currents are sufficient to implement this technique and the angular difference between fault and pre-fault current phasors are used as inputs to the fuzzy system. The fuzzy system is used to obtain the crisp output of the fault type. Fuzzy systems can be generally used for fault diagnosis.

Artificial Neural Networks and Expert systems can be used to improve the performance of the line. The environmental sensors sense the environmental and atmospheric conditions and give them as input to the expert systems. The expert systems are computer programs written by knowledge engineers which provide the value offline parameters to be deployed as the output. The ANNs are trained to change the values of line parameters over the given ranges based on the environmental conditions. Training algorithm has to be given to ANN. After training is over, the neural network is tested and the performance of the updates trained neural network is evaluated. If performance is not up to the desired level, some variations can be done like varying number of hidden layers, varying number of neurons in each layer. The processing speed is directly proportional to the number of neurons. These networks take different neurons for different layers and different activation functions between input and hidden layer and hidden and output layer to obtain the desired output. In this way the performance of the transmission line can be improved. [8]

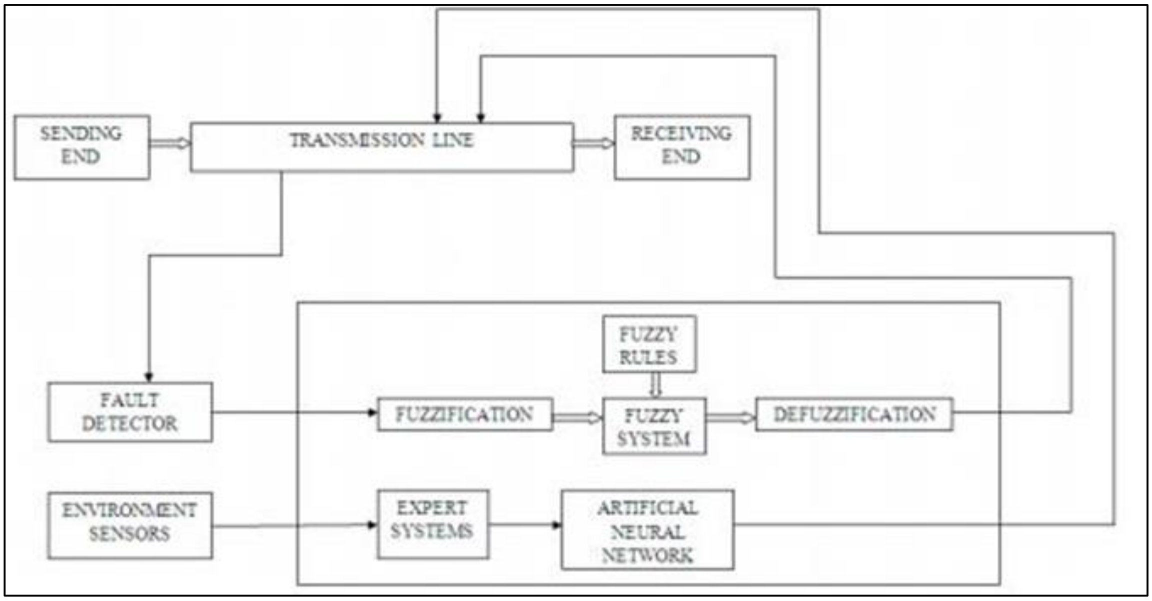

Fig. 5: Practical application of AI in Transmission lines

B. Applications in Other Fields

1) Game Playing

You can buy machines that can play master level chess for a few hundred dollars. There is some AI in them, but they play well against people, mainly through brute force computation looking at hundreds of thousands of positions. To beat a world champion by brute force and known reliable heuristics requires being able to look at 200 million positions per second. [7]

2) Speech Recognition

In the 1990s, computer speech recognition reached a practical level for limited purposes. Thus United Airlines have replaced its keyboard tree for flight information by a system using speech recognition of flight numbers and city names. It is quite convenient. On the other hand, while it is possible to instruct some computers using speech, most users have gone back to the keyboard and the mouse as still more convenient.

3) Understanding Natural Language

Just getting a sequence of words into a computer is not enough. Parsing sentences is not enough either. The computer has to be provided with an understanding of the domain the text is about, and this is presently possible only for very limited domains.

4) Computer Vision

The world is composed of three-dimensional objects, but the inputs to the human eye and computers' TV cameras are two dimensional. Some useful programs can work solely in two dimensions, but full computer vision requires partial three-dimensional information that is not just a set of two-dimensional views. At present there are only limited ways of representing three-dimensional information directly, and they are not as good as what humans evidently use.

VI. CONCLUSION

This paper concludes that Artificial intelligence can be a breakthrough in Electrical Engineering And can be implemented in power systems , power generation and transmission and can be use full in ecologically and economically.

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