OVERVIEW OF INTELLIGENT SYSTEMS

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Abstract: An intelligent system is a system that learns during its existence i.e. it senses its environment and learns from each situation and considers that action that is relevant to the existing condition. Thus we can say that artificial intelligent system is that system that functions in a same way a biological brain works. Artificial intelligence has a wide range of applications in today's world including medicine, stock trading, science, robotics, discovery, telecommunication and many more. This paper tries to review the basic concepts of AI and few applications of intelligent systems.
Keywords: Artificial intelligence, sub domains of AI, knowledge-based systems, neural networks, virtual reality.

Introduction

Intelligence refers to the ability of an individual to adapt himself to the changing demands of his environment and society, the mental adaptability to new tasks and circumstances in life. We can measure intelligence of a person by his way of grasping certain information, his judgment, his variability of thought in different situations and his ability to learn. Thus most importantly, we can define intelligence as the capability of a human being to adapt to his environment and hence assimilate his environment for solving problem.

Intelligent systems provide a standardized methodology to solve a complex or fairly complex problem and hence provide reliable results. Intelligence of a system can be determined in terms of its ability to learn, to adapt, to sense changes in environment, to offer solution in a changed condition and hence store this change in its system. The basis behind make of an intelligent system is artificial intelligence. It is basically divided into two categories: humanistic i.e. to think and act like humans and rationalistic i.e. to understand human behavior and intelligence.

Turing test can be used to test machine's ability to demonstrate intelligence. Turing test has the following procedure. A human judge C starts conversation with human B and machine A which also pretends to be human, wherein all participants are in isolation to each other. If judge C cannot reliably differentiate human B and machine A, machine is said to pass the test. Here we use text only such as keyboard or screen. But in an experiment "Chinese Room'' developed by John Searle in 1980 it was shown that a machine can never be properly described as having a mind or understanding even if it is intelligent. This means that manipulating formal symbols as was done in this experiment is just a computer running program and does not involve understanding or thinking.

1. Artificial Intelligence

Artificial intelligence can be defined as the intelligence artificially created and not existing naturally. We can also define it as a field that seeks to explain and emulate human behavior i.e. intelligence in terms of computational processes and this is based on results from philosophy, psychology and brain sciences. It is composed of two things- first to study the thinking ability of humans and secondly to represent it by the use of machines. Intelligence can thus be recognized as interlinking and processing of multiple processes and these

process models can be further be simulated on machines. Thus intelligent systems are a development of AI that provide certain features of human cognition i.e. knowledge gained by thought and perception and reasoning which are the abilities found in humans. AI can be used for information processing either by exact formulizations by or by eexemplary realisation via implementations. Thus the basic idea of AI is to make machines smarter and useful. Basically intelligence refers to the learning due to past experience, to create understanding of ambiguous message, adaptive to new conditions, recognizing different elements in a situation and developing solutions for problems. If we compare AI and Natural intelligence we say AI is more superior due to its lesser cost, ease of duplication and documentation, permanence and consistency. But on the other hand natural intelligence is creative and we can use its direct benefit and also through the sensory experiences, it enables us to sense the relationship between things.

According to Prof. Lofti A. Zadeh machine intelligence can be divided in two parts Hard Computing based on Artificial intelligence and soft computing techniques based on computational Intelligence. Hard computing is related with design of physical processes and systems and is based on binary logic, crisp systems, numerical analysis, differential equations, mathematical programming etc. soft computing is based on fuzzy logic, artificial neural networks, genetic algorithms and parts of machine learning etc. Imprecision and uncertainty is undesirable in hard computing whereas tolerance for imprecision and uncertainty is exploited to achieve approximate solutions. Combination of soft computing techniques is quite effective in many applications; like the use of neuro-fuzzy control is very popular in chemical process control of consumer goods. Fuzzy logic is mainly concerned with imprecision, neural network with learning and evolutionary algorithms with optimization.

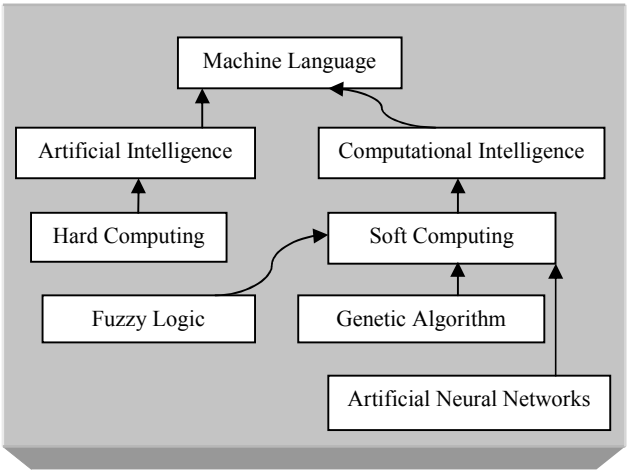

Fig.1 Artificial Intelligence vs. Computational Intelligence

1.1 Symbolic AI

AI builds up an intelligent system by first studying structure of a problem and then applying formal reasoning procedures in the structure. This is also known as top-down process which includes symbolic representations and manipulations. Symbols are names given to objects and thus we say spoken words are symbols of mental experience and written words are symbols of spoken words. Symbols can be used to inspect mental abilities of

humans which are independent of neuronal architectures. Thus symbolic AI is used to formulate intelligence models. The main functionary behind symbolic AI is "Intelligent Agent". It has following features:

- A memory and to act according to it
- Sensors to obtain information from the environment
- Actuators to level up to the perceived information
- Internal structure of memory containing methods and algorithms for providing knowledge to explore the environment

1.2 Sub symbolic AI

It is also called bottom-up approach in which structure is discovered later on and it is unordered method. Sub symbolic AI (SSAI) imitates the neural structure of brain which consists of neurons having weighted connections to each other. Thus using artificial neural networks provide the benefit of representation of fuzziness, parallel processing, speedy processing and high fault tolerance.

A system can be computationally intelligent if it is only intelligent in solving numerical problems and does not use it knowledge of AI.

1.3 Knowledge- Based System

It can be developed into following phases:

a. General problem solver

b. Knowledge-is-power hypothesis

c. Knowledge levels

d. Problem solving methods

a. General problem solver is a universal approach to solve problems. It differentiates between knowledge of problems domain and methods to solve problems. It provides restriction-free approach both on knowledge domain and on task. Examples include automated theorem proving and generic search methods. In GPS (generic search methods) every problems is used as a search. Example of this type is A* algorithm in which every problem is represented as state space. It uses the estimation function as:

$$F(n) = g(n) + h(n)$$

Where g (n) is the cost to get from the start state to current state n, h (n) is the estimated cost to get from current state n to end state and f (n) is estimated cost through current state n to end state.

b. Knowledge-is-power hypothesis was formulated by E.A. Feigenbaum in 1977:"knowledge of the specific task domain in which the program is to do its problem solving was more important as source of power for competent problem solving than the reasoning method employed". Problem solving is guided by experiential, qualitative, heuristic knowledge. Problem solving is guided by experiential, qualitative, heuristic knowledge. The Central Intelligence Agency (CIA) defines intelligence as knowledge. The Knowledge-is-power hypothesis lead to the emergence of a new filed i.e. **expert systems** and a new profession i.e. **knowledge engineer**.

c. Knowledge levels are classified into Newell's 3 levels of knowledge and Brachman's 5 levels of knowledge. Newell distinguished 3 levels in the context of knowledge representation intoKnowledge Level, Logical Level,

Implementation Level. Knowledge level involves all the knowledge contained in the knowledge base, for e.g. an automated database can be created wherein the prices of various trips can be included. Logical level means coding knowledge into formal language for e.g. price. Implementation level includes how we represent knowledge internally, for e.g. price can be represented as a value in a matrix. Brachman classifies knowledge in five levels which show the transition from data to knowledge where each level offers discrete sets of requirements to a knowledge engineer. The levels are named as Implementation Level, Logical Level, Epistemological Level, Conceptual Level and Linguistic Level. The implementation level involves pointers and memory cells and provides data storage with a number of semantics. Logical level involves logical predicates, operators and prepositions with an index for each. Epistemological Level involves concept types and structuring relations which provide structure in a network of conceptual types or units. This level links formal structure to conceptual units. Conceptual level involves conceptual relations, primitive objects and actions. And these primitives have cognitive interpretation corresponding to concepts like elementary actions. Linguistic level involves words and linguistic expressions which are derived from natural language.

d. Problem solving methods include inference actions to be done to solve a problem; it also tells the sequence in which actions have to carry out and the knowledge roles tells which role is to be played by knowledge field to carry out an inference action. Heuristic Classification describes the problem-solving behaviour of these systems on the Knowledge Level in a generic way. Propose and revise method is an efficient method for solving the task of parametric design which involves initial designing. C- Test to verify if designs are valid and then to improve n incorrect design based on C- test results.

Thus knowledge based systems (KBS) are based on a knowledge base which contains a model represented in a logical formalism which can be interpreted by an interpreter i.e. an inference engine that is able to draw conclusions. Example includes CYC that was the first system that was able to store common knowledge in a knowledge base.

Expert Systems (ES) is a special KBS which is a software application that stores knowledge about a certain domain. Or it can be defined as specially designed software with its decision taking capabilities comparable or exceeding the human expert in that field. It is able to draw conclusions from that knowledge and offers concrete solutions for problems in that domain. It contains knowledge base of highly specialized expert knowledge. Human experts are seen superior to ES as human experts are able to master unforeseen effects and situations, they are able to learn from experience, expand their knowledge continuously, derive new knowledge based on analogy and intuition. Thus advantages of ES include increased output, quality and productivity, expertise and dissemination, workability in conditions harmful to humans, reliability, increased output combined with other computerized systems, ability to work with incomplete or uncertain information, availability of training, lesser decision-time and increased problem solving capabilities. Many intelligent systems include natural language processing (NLP) and voice technology, neural computing, fuzzy logic, intelligent systems.

1.4 Practical applications of AI systems

The popular AI developed and hence used are:

ELIZA: Eliza was an early computer program of natural language processing which was written by J. Weizenbaum. This application simulated a psychotherapist by reformulating questions posed by the user.

Deep Blue: It is a chess-playing computer developed by IBM that won against world champion Garry Kasparov in 1997. It applied a highly parallel processing and had evaluation of 200 million positions per second. Its knowledge base includes 4,000 positions and 700,000 grandmaster games. It was further fine-tuned by chess-grandmasters. IBM states that today it is not a learning system and therefore is not capable of utilizing artificial intelligence to either learn from its opponent or think about the current position of the chessboard.

Humanoid Robot COG: It was developed at MIT Artificial Intelligence Lab and it had the capabilities of interacting with humans and objects in a human-like way.

CALO (Cognitive Assistant that Learns and Organizes): It is a project funded by DARPA which involves 25 partners, 300+ researchers and it is personal assistant that learns. The of the project is to create cognitive software systems, i.e. the systems that can reason, learn from experience and be told what to do, explain what they are doing, reflect on their experience, and respond robustly to surprise.

HAL 9000: It is an advanced device capable of performing variety of tasks and interacting with its human companions by voice or can control an auxiliary device on a spaceship. But it has unfortunate tendency towards obsessing over minor details or inconsistencies in the instructions given to it.
Other applications of AI are SEAS ("Synthetic Environment for Analysis and Simulation") which can be used to simulate realistic events and has a world model, SYSTRAN which was an early machine translation system and is a foundation for Yahoo's Babel fish or Google Translator, Virtual Woman which is a Virtual-reality based Chabot.

2. Soft Computing

Soft computing is a combination of methodologies which gives the basis of deigning an intelligent system. It utilizes the concept of human ability to take decisions in an uncertain and imprecise environment. It uses fuzzy logic, neural networks and evolutionary computation techniques.

Fuzzy Logic: we refer fuzziness as vague and unclear and most of the information in this world is fuzzy. In classical crisp theory of sets we define whether element is either the member of set or not. But in fuzzy set every element has a degree of membership with the set. Major areas of application are fuzzy control and fuzzy expert systems.

Neural Networks: it is roughly modelled as the structure of a brain. It can deal with noisy and variable information. Its uses include content addressable memory, clustering, control systems etc.

Evolutionary Computing: it is basically optimization techniques based on biological genetics and natural selection. It includes genetic algorithms, evolutionary programming, and particle swarm optimization, bacterial foraging, and memetic algorithm etc. Evolutionary programming algorithms are similar to genetic algorithms, but do not incorporate crossover but they rely on survival of the fittest and mutation. Evolution strategies are

similar to genetic algorithms but use recombination to exchange information between population members instead of crossover, and often use a different type of mutation as well. The structures being manipulated are usually hierarchical tree structures. Particle swarm optimization flies potential solutions, called particles, through the problem space. The particles are accelerated toward selected points in the problem space where previous fitness values have been high. Evolutionary algorithms have been applied in optimization to multiple-fault diagnosis, robot track determination, schedule optimization, conformal analysis of DNA, and load distribution by electric utility, neural network explanation facilities, and product ingredient mix optimization.

3. Sub domains of AI

Thus AI can be subdivided in following domains i.e. Cognition as information processing, Artificial neuronal networks, Heuristic search methods, Knowledge representation and logic, Automatic theorem proving, Non-monotonic reasoning, Case-based reasoning, Planning, Machine Learning, Knowledge Engineering, Natural Language Processing, Image Understanding, Cognitive Robotics, Software Agents.

Cognition

It deals with complex software systems that directly interact and communicate with human users. CS are made in their environment, act and communicate with it. They are also capable of adapting themselves and they have information processing capabilities that are characterized through learning aptitude and anticipation. The examples include Organisms / biological cognitive systems, Technical systems such as robots or agents, mixed human-machine systems.

Neural Networks

Neural networks are networks of neurons as in a real biological brain. Neurons are highly specialized cells that transmit impulses within animals to cause a change in a target cell such as a muscle effecter cell or glandular cell. The axon is the primary conduit through which the neuron transmits impulses to neurons downstream in the signal chain. Humans have about 10^{11} neurons of more than 20 types, 10^{14} synapses, 1ms-10ms cycle time. Signals involved are noisy "spike trains" of electrical potential.

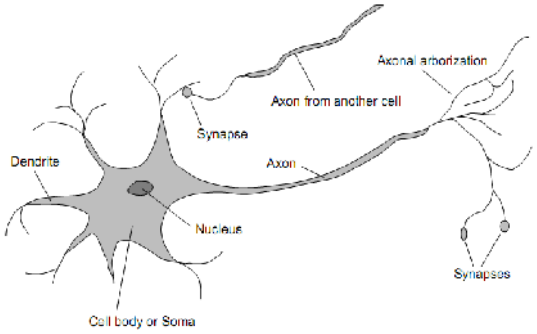

Fig.2 Structure of Neuron

We refer to as Neural Networks in the course are mostly Artificial Neural Networks (ANN) .ANN are approximation of biological neural networks and are built of physical devices, or simulated on computers. ANN are parallel computational entities that consist of multiple simple processing units that are connected in specific

ways in order to perform the desired tasks. e.g., handwriting recognition, time series prediction, kernel machines (support vector machines), data compression, financial predication, speech recognition, computer vision, protein structures. Benefits of neural computing include the human related characteristics of problem solving, fault-tolerence, generalization. Adaptibility etc. The applications of AI include Tax fraud, Financial services, Loan applications evaluation, Solvency prediction, New product analysis, Airline fare management, Prediction, Evaluation of personnel and job candidates, Resource allocation , Data mining, Foreign exchange rate, Stock, bond, and commodities selection and trading, Signature validation.

Search methods

Search methods are methods which generate plans containing sequences/actions to reach a goal state. It is defined by picking the order of node expansion. These are evaluated according to completeness, time and space complexity and optimality.

Knowledge representation and logic

Knowledge representation describes the design and implementation of formalisms to model a part of reality. And this model is represented using formalisms and is implemented by an interpreter is often called as knowledge base which is a collection of facts and beliefs. Logic gives the principle of reasoning and thus provides formal languages for expressing it, formal semantics and reasoning methods to make implicit knowledge explicit.

Case-based reasoning

A case is defined as an experience made during solving a problem and it is usually informally given. Cases are collected in a case-base and cases are used to solve newly occurring problems. This type of reasoning is derived from human nature of solving problems. Its uses include diagnostics, electronic sales, configuration or planning.

Planning

Planning is the process of thinking about activities required to create a desired goal on same scale. It is flexible approach for taking complex decisions.

Machine Learning

It is a central research area in AI to acquire knowledge. It deals with computer-aided design and realization of learning problems. It is the process which makes the system to perform better in a situation similar in future using the previously acquired knowledge. Its uses are in data mining, speech recognition, text analysis, control learning, hidden markov networks etc.

Knowledge Engineering

It is concerned with acquisition, management, use and transformation of knowledge. Its basic is knowledge acquisition and knowledge is formalized i.e. converted from natural form. Applications include development of expert systems, workflow systems or knowledge management.

Natural Language processing

Its use is to process and understand speech or written language. Previously these systems were employed in question-answer systems, natural-language based access to databases or speech-based control of robots. Its advantages include ease of access, speed, manual freedom, remote access and accuracy.

Image understanding

It deals with analysis and interpretation of visual information. It involves reconstruction and interpretation of scenes based on images. It is mostly used as object recognition of still and moving objects. Its uses are in symbol recognition, medical image analysis, vehicle navigation, image archiving, and gesture recognition.

Cognitive robotics

It involves many interdisciplinary work including mechanic and electrical design and cognitive areas. Various types of robots are designed including static robots, mobile robots, and humanoid robots. Areas of application include construction, planning or observation.

Software agents

They are also called as intelligent agents and their major tasks involve information access and navigation, Decision support and empowerment, Repetitive office activity, mundane personal activity, Search and retrieval, Domain experts. Agent has a memory, capability to act in world, sensors to perceive information, actuators, capability to take actions, internal memory for exploration of this world.

Applications include data collection and filtering, event notification, planning and optimization in various application areas.

Fuzzy logic

Fuzzy logic is a technique that deals with uncertainties by simulating the process of human reasoning, making the computer to behave less precisely and logically.

4. Virtual Reality

As is defined in Wikipedia Virtual reality (VR) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. These are mainly consisting of visual experiences displayed on a computer screen or through special stereoscopic displays and some additional sensory information such as sound through speaker or headphones. They create a similar real world or life-like environment. VR covers communications in remote areas which provides virtual presence of users and imply telepresence and telexistence or a virtual artifact (VA) though keyboards, mouse, wired gloves and omnidirectional treadmills. But it is difficult to create a virtual environment close to reality due to technical limitations on processing power, image resolution and bandwidth. It is largely used to create 3-D environments.

Fig.3 U.S. Navy personnel using VR parachute trainer

VR is widely used in heritage and archeology and hence applications in museum and visitor centre. These historic reconstructions are in shared video display allowing more than one person to see it. The very first application of it was a 3-D reconstruction of Dudley Castle in England in 1550. This consisted of a computer controlled laserdisc-based system designed by British based engineer Colin Johnson and one of the first users of virtual reality was Queen Elizabeth II, when she officially opened this visitor centre in June 1994. The original sites are inaccessible to people and in future will not be available. VR creates duplicates of caves, natural environment, old towns, and sculptures etc. Motion pictures are also made which use the idea if virtual reality like Steven Lisberger's 1982 film Tron, in 1983, the Natalie Wood / Christopher Walken film Brainstorm, Wim Wenders' 1991 film Until the End of the World, the 1992 film The Lawnmower Man, 1994's Disclosure, The Thirteenth Floor (1999), in 1999, The Matrix and later sequels, the 2001 Mamoru Oshii movie "Avalon", "Inception," made in 2010 etc.

VR is also used for therapeutic purposes like in exposure therapy, phobia treatment like zoophobia and acrophobia. Other research areas include physical medicine, rehabilitation, physical therapy and occupational therapy. VR can also be used for new product design, prototypes, CAD, electronic design automation, computer aided manufacturing etc. 3D printing can be used to create physical parts of real objects used in naval, aerospace and automotive industries etc.

Conclusion

Thus we conclude that intelligent systems are widely being deployed in many areas today. Many researches are also ongoing in certain areas like use of computer to model the behavioural aspects of human reasoning and learning. Today AI has become an indispensible part of technology industry in providing the heavy lifting in many problem areas in computer science.

References

Albus, J. S., n.d. A Reference Model Architecture for Intelligent Systems Design. s.l.:National Institute of Standards and Technology.

Biletskiy, Y., Ranganathan, G. & Brown, J., 2008. Representing user friendly rules in a semantic web based format. ISAST Transactions on Computers and Software Engineering, 2(8-12).

Brady, M. & Hilary, F., 2005. Intelligent Systems to Support Patient Management. [Online] Available at: http://www.robots.ox.ac.uk/~jmb/lectures/InformaticsLectures34.pdf [Accessed June 2012].

Burnham, J., n.d. The Aesthetics of Intelligent Systems. In: Beyond Modern Sculpture. s.l.:s.n.

Fensel, D., Toma, I. & Buerger, T., 2009. Intelligent systems. [Online] Available at: http://www.sti-innsbruck.at/teaching/courses/ws200910/details/title=intelligente-systeme [Accessed June 2012].

Jackson, W., 1999. Intelligent Support Systems. s.l.:John Wiley & Sons.

Petkov, N., Biehl, M. & Wilkinson, M., 2006. Intelligent Systems. s.l.:MSc Variant Intelligent Systems.

Rudas, I. J. & Fodor, J., 2008. Intelligent Systems. International Journal of Computers, Communications and Control, pp. 132-138.