Artificial Intelligence Technologies

by

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Highlights of my talk

- ***AI – definitions***
- ***AI – goals***
- ***AI – technology timeline***
- ***AI – events timeline***
- ***AI – lab to real world***
- ***AI – national endeavor***
- ***AI – fragmented into sub disciplines***
- ***AI – future***
- ***AI – conclusion***

Artificial Intelligence Technologies

- ***The term "artificial intelligence" was coined in 1950s.***

  It is about creation of machines that perform tasks that, if performed by a human, would require intelligence.

- *Artificial intelligence (AI) is unique, sharing borders with mathematics, computer science, philosophy, psychology, biology, cognitive science and many others.*

- *Although there is no clear definition of Artificial Intelligence or even Intelligence, it can be described as an attempt to build machines that like humans can think and act, able to learn and use knowledge to solve problems on their own.*

- *Researchers are creating systems which can mimic human thought, understand speech, beat the best human chess player, and countless other feats never before possible.*

▶ *To be more specific, the definitions of artificial intelligence outlined in recent text books are :*

(a) ". . . effort to make computers think . . . machines with minds, in full and literal sense" (Haugeland, 1985)	***(b) ". . study of mental faculties through the use of computational models" (Charniak and McDermott, 1985)***
". . automation of activities . . decision-making, problem solving, learning ..." (Bellman, 1978)	***". . computations that make it possible to perceive, reason, and act" (Winston, 1992)***
(C) ". . creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)	***(d) ". . explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990)***
". . how to make computers do things at which, at the moment, people are better" (Rich and Knight, 1991)	***". . concerned with the automation of intelligent behavior" (Luger and Stubblefield, 1993)***

The definitions on the top, (a) and (b) are concerned with reasoning, and those on the bottom, (c) and (d) address behavior.

The definitions on the left, (a) and (c) measure success in terms of human performance, and those on the right, (b) and (d) measure ideal concept of intelligence called rationality.

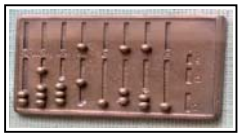
▶ *The definitions of AI gives four possible goals to pursue following four different approaches .*

	Human-like:	Rationally:
Think:	**Cognitive science Approach** **Machines that think like humans.** **but humans do not always operate by logic, thoughts are affected by emotions**	**Laws of thought Approach** **Machines that think rationally.** **but humans do not always follow the rules and logic, make errors.**
Act:	**Turing Test Approach** **Machines that behave like humans.** **but humans do not always accomplish a task correctly, make mistakes.**	**Rational agent Approach** **Machines that behave rationally** **but programmers do not care how computer think, want to perform a task correctly.**

Timeline of AI related technology

Roots of AI - The development of artificial intelligence actually began centuries ago, long before the computer.

Roman Abacus **, 5000 years ago, machine with memory,**

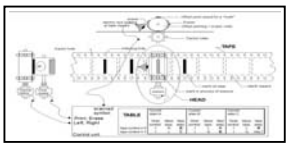


Pascaline, 1652 **, Calculating machines that mechanized arithmetic ,**

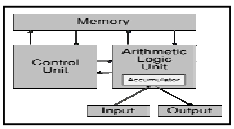
Diff. Engine, 1849 **, Mechanical calculating machines Programmable to tabulate polynomial functions.**

Boolean algebra, 1854, **" Investigation of laws of Thought" symbolic language of calculus.**

Turing machines, 1936, **abstract symbol-manipulating devices, adapted to simulate the logic, is first computer invented (on paper only).**



Von Neumann architecture, 1945, **Computer design model, a processing unit and a shared memory structure to hold both instructions and data.**



ENIAC, 1946, **first electronic "general-purpose" Digital Computers computer by Eckert and Mauchly. (Electronic Numerical Integrator and Calculator),**

Timeline of AI events

The concept of AI as a true scientific pursuit is a very young. It remained over centuries a plot for popular science fiction stories. Most researchers agree the beginning of AI with Alan Turing.

1950, Turing test, by Alan Turing, a measure of machine intelligence, in the paper "Computing Machinery and Intelligence".

The test called for a human judge to use a computer terminal to interact with human as well as with the machine; if the judge cannot reliably tell which is which, then the machine is said to pass the test and the machine would be considered intelligent.

1950, Norbert Wiener, observed link between human intelligence and machines, theorized intelligent behavior.

1955, Logic Theorist, a program by Allen Newell and Herbert Simon, claimed that machines can contain minds just as human bodies do, proved 38 of the first 52 theorems in Principia Mathematica.

1956, Birth of AI, Dartmouth Summer Research Conference on Artificial Intelligence , organised by John McCarthy regarded as the father of AI.

The conference lasted a month, was essentially an extended brain-storming session, to draw the talent and expertise of others interested in machine intelligence. ***The term artificial intelligence was first coined****. The Dartmouth conference served to lay the groundwork for the future of AI research and discussed computers, natural language processing, neural networks, theory of computation, abstraction and creativity - all still open research areas.*

1963, Seven years after, AI began to pick up momentum, the field was still undefined, ideas formed at the conference were re-examined.

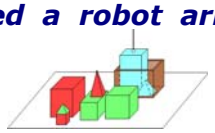
Centers for AI research began forming at Carnegie Mellon and MIT, and new challenges were faced, further research was placed upon creating systems that could efficiently solve problems, such as the Logic Theorist and making systems that could learn by themselves.

1957, General Problem Solver (GPS), was tested. The GPS was an extension of Wiener's feedback principle, and was capable of solving to a greater extent the common sense problems.

1958, LISP language, was invented by McCarthy and soon adopted as the language of choice among most AI developers.

1963, Start of DoD's Advanced Research projects, at MIT, researching Machine-Aided Cognition (artificial intelligence), by drawing computer scientists from around the world.

1968, Micro-world program SHRDLU, at MIT, controlled a robot arm operated above flat surface scattered with play blocks.



SHRDLU, could plan, carry on simple conversations typed in natural English, like " . . stack up both of the red blocks and either a green cube or a pyramid".

Mid-1970's, Expert systems, for medical diagnosis (Mycin), chemical data analysis (Dendral) and mineral exploration (Prospector).

Feigenbum defined an expert system as an intelligent computer program that uses knowledge and inference procedure to solve problems difficult enough, to require significant human expertise for their solution. A typical expert system consists of five components : user interface, working memory, the knowledge base, the inference engine, and explanation system.

During 1970's, Computer vision technology of machines that "see". David Marr, was among the first to model the function of the visual system.

The purpose of computer vision is to program a computer to "understand" a scene or features in an image. It is a combination of concepts, techniques and ideas from Digital Image Processing, Pattern Recognition, Artificial Intelligence and Computer Graphics.

1972, Prolog, a logic programming language, by Alain Colmerauer.

Logic programming, is the use of logic as both a declarative and procedural representation language. It is based upon the fact that a backwards reasoning theorem-prover applied to declarative sentences in the form of implications : If B1 and B2 . . . and Bn then H.

Transition from Lab to Real world

The impact of AI and the computer technology were felt. Foundations like "American Association for Artificial Intelligence started". The demand for AI development, pushed the researchers to join 150 private companies. DEC, AI group employed 700 personnel, spend $1 billion on internal research.

1986, AI based hardware, cost $425 million, sold to companies.

Other fields of AI also made their way into the marketplace; over a hundred companies offered machine vision systems in the US, and sales totaled $80 million.

1991, AI military systems put to test of war, during "Desert Strom".

New technology development showed real life uses.

Fuzzy logic, showed ability to make decisions under uncertain conditions.

Neural networks, a possible ways of achieving Artificial Intelligence.

National Endeavor – one typical case

In early 1970's, the aerial and Landsat-1 imagery of 80 meter resolution paved way for initiation of the Remote sensing and Image processing activities in the country.

Satellite images, resolution 1 km, Bhaskara-I (1979) , Bhaskara-II (1981).

1981, DRDO initiated a small project on Image processing.

1984, "Brain Storming Session on Image processing", inviting experts from academic and R&D institutions.

The session continued for 3-days, with 12 experts, from I.S.I, Calcutta, IIT Mumbai, IIT-Kharagpur. IIT-Roorkee. IIT-Delhi. IIT-Kanpur, IISC Bangalore, NRSA Hyderabad, SAC Ahmedabad and DRDO/DEAL. The aim was to identify the projects that need cooperative efforts at National Level.

Satellite images, resolution 10 m, SPOT-1 (1986), SPOT-2(1990), SPOT-3 (1993),
Satellite images, resolution 36 m, IRS-1A (1988), IRS-1B (1991), IRS-P2 (1994),

1990-95, Project " DIPTA", a National endeavor for Machine Interpretation of remotely sensed images in terms of human concepts, combining techniques of artificial intelligence, pattern recognition and image analysis.

This project continued for 5 years, with the participation of academic and industry experts. Each institutions worked on a sub projects, in the area they had expertise like, Knowledge Based system (IIT Kh), Black Board Architecture (IIT D), Fuzzy classifier (ISI Cal), Multi-spectral statistical classifier (ISI Cal), Intelligent interface (Pune Uni.), GIS & 3-D model (Peagus), Fly/walk through TCS etc. The in-house activities were carried through 18-20 scientist. They worked on Image registration, Supervise and unsupervised clustering, Region extraction, Shape analysis for man-made object recognition, Rule based knowledge representation, Semantic reasoning, and Fuzzy based inferencing; all these technologies leading to target detection, identification and recognition. The software developed were tested and validated using satellite IRS 1A & 1B images of resolution 36 meter, and SPOT-1 & SPOT-2 images of resolution 10/20 meter. (Ref. RC Chakraborty, Defence Science Journal, Vol 45, No. 4, Oct. 1995, pp 307-313).

Satellite images, resolution 5.8 m, IRS-1C (1995), IRS-1D (1997)

***1996-2000, Project SARVADRISTA*, a major hardware and software development effort with the involvement of public/pvt. sectors.**

Because of high resolution satellite images, that too from indigenous sources, users expectations and demands crossed all bounds. This project continued for 4 years. Established an Earth Station (9 meter dish, X-band carrier, and 100 Mbit data rate) for reception of Imageries from satellites in polar orbits, Sat-Com terminals (6 meter Ext. C-band) to disseminate Imageries using communication satellites in Geo-sync orbit. All technology developments were directed to smaller and smaller target detection, identification, recognition and generation of user defined products.

AI fragmented into sub-disciplines

- *Multi-Agent Systems*
- *Cognitive modeling and human interaction*
- *Commonsense reasoning*
- *Constraint satisfaction*
- *Evolutionary computation*
- *Game playing and interactive entertainment*
- *Information integration and extraction*
- *Knowledge acquisition and ontologies*
- *Knowledge representation and reasoning*
- *Machine learning and data mining*
- Model-based systems
- Natural language processing
- Planning and scheduling
- Probabilistic reasoning
- Robotics
- Search
- Semantic web
- Vision and perception

2000 – New Millennium

Strong AI : Trying to build a system that is equal or better than a human, on general tasks. Weizenbaum's view (MIT): The goal of strong AI is "Nothing less than to build a machine on the model of man, a robot that is to have its childhood, to learn language as a child does, to gain its knowledge of the world by sensing the world through its own organs, and ultimately to contemplate the whole domain of human thought."

Weak AI : Building useful applications, usually restricted to a particular domain, specific tasks, e.g. an autonomous vehicle, speech recognition system and many more.

Most people work on weak AI : Many people wonder why more people don't work on strong AI, Perhaps the history of AI answers this question… Because people working on strong AI don't get anywhere!

▶ Conclusion

Despite the advances in the last 50 years, the original goals set by the first generation of AI visionaries have not been reached. Not only the natural intelligence is far from being understood, the artificial forms of intelligence is still very primitive. Simple tasks like object manipulation and recognition - which a 3-year-old can do - have not yet been realized artificially.

(Ref : 50th Anniversary Summit of Artificial Intelligence, Centro Steno Franscini – Monte Verita Switzer Land, July 9-14, 2006).

References : *Open sources – mainly internet.*

Note : This talk has been prepared, using information available from open sources, mainly internet sources, for bringing general awareness about Artificial Intelligence technologies. There is no commercial interest, what so ever, is involved.