Inteligencia Artificial

The history of artificial intelligence, or from the 'Dark Ages' to Knowledge-based systems

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Artificial intelligence as a science was founded by three generations of researchers. Some of the most important events and contributors from each generation are described next.

The 'Dark Ages', or the birth of artificial intelligence (1943-56)

The first work recognised in the field of artificial intelligence (AI) was presented by Warren McCulloch and Walter Pitts in 1943. His research on the central nervous system resulted in the first major contribution to AI: a model of neurons of the brain.

McCulloch and his co-author Walter Pitts, a young mathematician, proposed a model of artificial neural networks in which each neuron was postulated as being in binary state, that is, in either on or off condition (McCulloch an Pitts, 1943). McCulloch and Pitts also showed that simple network structures could learn.

The neural network model simulated both theorical and experimental work to model the brain in the laboratory. McCulloch, the second 'founding father' of AI after Alan Turing, had created the cornerstone of neural computing and artificial neural networks (ANN).

The third founder of AI was John von Neumann, the brilliant hungarian-born mathematician. When Marvin Minsky and Dean Edmonds, two graduate students in the Princeton mathematics department, built the first neural network computer in 1951, von Neumann encouraged and supported them.

Another of the first-generation researchers was Claude Shannon. Thus, Shannon demostrated the need to use heuristics in the search for the solution.

Princeton University was also home to John McCarthy, another founder of AI. He convinced Martin Minsky and Claude Shannon to organise a summer workshop at Dartmouth College, where McCarthy worked after graduating from Princeton.

The rise of artificial intelligence, or the era of great expectations (1956-late 1960s)

The early years of AI are characterised by tremendous enthusiasm, great ideas and very limited sucess. Only a few years before, computers had been introduced

to perform routine mathematical calculations, but now AI researchers were demostrating that computers could do more than that.
John McCarthy, one of the organisers of the Dartmouth workshop and the inventor of the term 'artificial intelligence', moved from Dartmouth to MIT. He defined the high-level language LISP - One of the oldest programming languages (FORTRAN is just two years older), which is still in current use.
Another organiser of the Dartmouth workshop, Marvin Minsky, also moved to MIT. His theory of frames (Minsky, 1975) was a major contribution to knowledge engineering.
Learning methods were improved and Frank Rosenblatt proved the perceptron convergence theorem, demostrating that his learning algorithm could adjust the connection strengths of a perceptron (Rosenblatt, 1962).
One of the most ambitious projects of the era of great expectations was the General Problem Solver (GPS) (Newell and Simon, 1961, 1972).
Newell and Simon postulated that a problem to be solved could be defined in terms of states. The means-ends analysis was used to determine a difference between the current state and the desirable state or the goal state of the problem, and to choose and apply operators to reach the goal state.
In summary, we can say that in the 1960s, AI researchers attempted to simulate the complex thinking process by inventing general methods for solving broad classes of problems.
By 1970, the euphoria about AI was gone, and most government funding for AI projects was cancelled. AI was still a relatively new field, academic in nature, with few practical applications apart from playing games (Samuel, 1959, 1967; Greenblatt et al., 1967).

Unfulfilled promises, or the impact of realty (late 1960s - early 1970s)
From the mid-1950s, AI researchers were making promises to build all-purpose intelligent machines on a human-scale knowledge base by the 1980s, and to exceed human intelligence by the year 2000. By 1970, however, they realised that such claims were too optimistic.
In 1971, the british government also suspended support for AI research. Sir James Lighthill had been commissioned by the Science Research Council of

Great britain to review the current state of AI (Lighthill, 1973).

The technology of expert systems, or the key to success (early 1970s - mid 1980s)

Probably the most important development in the 1970s was the realisation that the problem domain for intelligent machines had to be sufficiently restricted. A general-purpose search mechanism could rely on elementary reasoning steps to find complete solutions and could use weak knowledge about domain.
The DENDRAL program is a typical example of the emerging technology (Buchanan et al. 1969). DENDRAL was developed at Stanford University to analyse chemicals.
DENDRAL marked a major "paradigm shift" in AI: a shift from general purpose, knowledge-sparse, weak methods to domain-specific, knowledge intensive techniques.
Expert systems are also difficult to verify and validate. No general technique has yet been developed for analysing their completeness and consistency.
Expert systems, especially the first generation, have little or no ability to learn from their experience. Expert systems are built individually and cannot be developed fast.

How to make a machine learn, or the rebirth of neural networks (mid-1980s - onwards)

In the mid-1980s, AI researchers revisited neural networks after disillusionment with expert systems led to predictions of an AI winter. Although the fundamental concepts of neural computing had been established by the 1960s, limitations of early perceptrons, as demonstrated by Minsky and Papert (1969), caused interest in neural networks to decline in the 1970s.
The most significant milestone was the reinvention of the backpropagation learning algorithm by Rumelhart and McClelland (1986), originally introduced by Bryson and Ho (1969). This breakthrough, along with contributions from Parker (1987) and LeCun (1988), made backpropagation the dominant technique for training multilayer perceptrons. Additionally, Broomhead and Lowe (1988) introduced radial basis function networks as an alternative approach.

Evolutionary computation, or learning by doing (early 1970s-onwards)
Natural intelligence is a product of evolution, and artifical intelligence researchers have drawn inspiration from biological process to create intelligent systems. Evolutionary computation is based on the idea that solutions to complex problems can be found through simulating natural selection- where individuals compete for survival, and the fittest solutions are more likely to be passed on to future generations.
John Holland (1975), introduced genetic algorithms, which apply evolutionary principles to problem solving. These algorithms use artificial "chromosomes" (binary-encoded strings) and apply three genetic operations:
- Selection- favoring the best-performing solutions.
- Crossover- Combining features from different solutions.
- Mutation- Introducing random variations for exploration.

Instead of evolving parameter values, Genetic Programming (GP), popularized by John Koza (1992, 1994), evolves computer programs themselves.
Evolutionary computation provides robust solutions to highly complex, nonlinear, and multidimensional problems that traditional methods struggle with.

The new era of Knowledge engineering, or computing with words (late 1980s-onwards)
As artificial intelligence evolved, researchers realized that different techiques could be combined to create more powerful and human-like AI systems. This era saw the integration of neural networks, expert systems, and fuzzy logic, leading to more adaptable, explainable, and efficient AI applications.
Neural networks are excellent at recognizing patterns, adapting to changes, and handling complex, unstructured data. However, they function as 'black boxes'- meaning their reasoning is difficult to interpret.
Expert Systems, based on symbolic reasoning, use predefined rules from human experts. While they provide clear explanations, they struggle with ambiguous or incomplete data.
Introduced by Lotfi Zadeh (1965), fuzzy logic bridges the gap between human reasoning and computational systems by allowing AI to process vague and uncertain information. Instead of binary "true/false" logic, fuzzy logic uses linguistic variables and degrees of truth.
Initially slow to gain acceptance, fuzzy logic was embraced by Japanese industries in the 1980s
By combining learning, reasoning, and uncertainty management, AI is moving towards more atonomous, explainable, and intelligent systems capable of solving real-world problems.