Artificial Intelligence - A Guide to Intelligent Systems
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1.2.1 The 'Dark Ages', or the birth of artificial intelligence (1943 - 56)

In 1943, Warren McCulloch and Walter Pitts presented the first recognized work in artificial inteligence (AI), proposing a model of artificial neural networks. Despite the binary neuron model's later experimental shortcomings, McCulloch became a key figure in AI. John von Neuman influenced by McCulloch's work, supported the creation of the first neural network computer in 1951.

Claude Shannon, sharing ideas with Alan Turing, highlighted the need for heuristics in solving complex problems in a 1950 paper on chess-playing machines. In 1956, John McCarthy, along with Minsky and Shannon, organized a workshop at Dartmouth College, marking the formal beginning of AI as a new science. Over the next two decades, AI research was dominant by participants in the Dartmouth workshop and their students.

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

In the 1956-late 1960's era of AI, marked by the Dartmouth workshop, John McCarthy coined the term 'artificial intelligence' and developed the LISP language. He proposed the Advice Taker, the first knowledge-based system. Marvin Minsky introduced the theory of frames. Advances in neural computing continued, and the General Problem Solver (GPS) by Allen Newell and Herbert Simon aimed to simulate human problem-solving but faced challenged and was abandoned.

1.2.3 Unfulfilled promises, or the impact of reality (late 1960s - early 1970s)

In the late 1960s and early 1970s, AI researchers fell short of promises to create human-scale intelligent machines by the 1980s. While some programs showed limited intelligence in toy problems, broader tasks and real-world challenges proved difficult. AI faced issues with general methods lacking domain-specific knowledge and a misconception about scaling up.

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1.2.4 The technology of expert systems, or the key to success

In the early 1970's, a crucial shift occurred in AI with the realization tha successful intelligent machines needed to focus on narrow domains. This marked a paradigm shift from general-purpose, knowledge-sparse, weak methods to domain-specific, knowledge-intensive techniques. The DENDRAL program exemplified this shift by successfully analyzing chemicals, using specific rules elicited from human experts, forming the basis of the first knowledge-based system.

DENDRAL'S significance included a paradigm shift in AI, achieving expert-level performance in narrow domains, and pioneering the methodology of expert systems, known as knowledge engineering. Subsequent projects like MYCIN and PROSPECTOR further demonstrated the success of expert systems in medical diagnosis and mineral exploration, respectively. Despite limitations such as narrow domain expertise, lack of robustness, and challenges in verification, expert systems gained traction in various applications, proving their value by the late 1970s.

1.2.5 How to make a machine learn, or the rebirth of neural networks

In the mid-1980s, disillusionment with experts systems led to a reevaluation of AI approaches, triggering a resurgence of interest in neural networks. Although foundational concepts for neural computing existed since the late 1960s, technological limitations and theoretical setbacks, such as Minsky and Papert's work on one-layer perceptions, hindered progress in the 1970s.

The 1980s saw a dramatic revival of neural networks due to advancements in computer technology, progress in neuroscience, and the brain-like information processing. Key contributions included Grossberg's adaptive resonance theory, Hopfield networks with feedback by Hopfield, Kohonen's self-organized maps, and re-inforcement learning work by Barto, Sutton, and Anderson. The breakthrough came in 1986 with the rediscovery of the back-propagation learning algorithm by Rumelhart and McClelland, Parker, and LeCun, making it the most popular technique for training multiplayer perceptions.

1.2.6 Evolutionary computation, or learning by doing

Evolutionary computation in AI draws inspiration from natural evolution, simulating biological processes to achieve high-level intelligence. This approach involves simulating populations, evaluating performance, and generating new populations. The three main techniques are genetic algorithms, evolutionary strategies, and genetic programming. Genetic algorithms, introduced by John Holland, manipulate artificial "chromosomes" using genetic operations. Evolutionary strategies, proposed by Ingo Rechenberg and Hans-Paul Shwefel, focus on solving parameter optimization problems through random changes. Both excel in solving complex, nonlinear search, and optimization problems.

1.2.7 The new era of knowledge engineering, or computing with words

Neural network technology, with its ability to learn, adapt, and handle fuzzy or incorporate information, provides a more natural interaction with the real world than symbolic reasoning systems. Despite lacking explanation facilities and slow training processes, neural networks complement expert systems. Expert Systems, proficient in closed-system applications, benefit from neural networks in extracting hidden knowledge from large datasets and refining rules.

Fuzzy logic, introduced by Lofti Zadeh, addresses imprecision, capturing human reasoning with linguistic variables. While fuzzy logic applications are prominent in control engineering, its benefits extend to improved computational power, enhanced cognitive modeling, and representing multiple experts. The synergy of expert systems, fuzzy logic, and neural computing enhances adaptability, robustness, fault-tolerance, and speed in knowledge-based systems, ushering a new era of knowledge engineering.