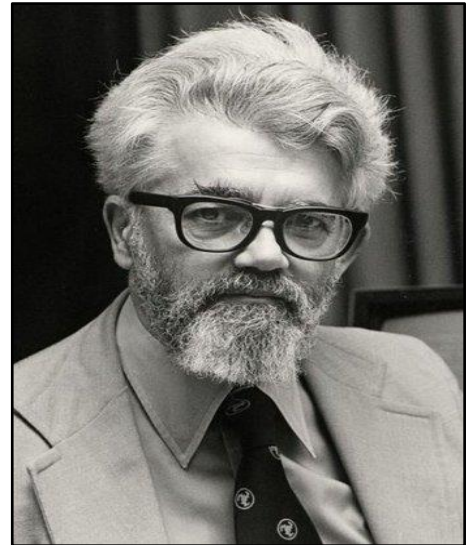


John McCarthy

Overview

John McCarthy was an American computer scientist and cognitive scientist and is considered by many as one of the founding fathers of artificial intelligence. McCarthy has been a major influence in many other areas of computer science and software engineering, including the development of both the LISP and ALGOL programming languages, as well as inventing “garbage collection” and popularizing the process of time-sharing. McCarthy is known as one of the most inventive computer scientists in modern history.



Early Life and Education

McCarthy was born in Boston on September 4, 1927, to a Lithuanian Jewish mother and an Irish immigrant father. McCarthy excelled at a young age and was accepted into Caltech in 1944 after graduating from high school two years early. From a young age McCarthy showed an aptitude for mathematics and graduated from Caltech with a Bachelor of Science degree in mathematics in 1948. He then went on to earn a PhD in the same field from Princeton University in 1951. His interest in mathematics, cognitive science, and computer science would prove pivotal in his later research and work on artificial intelligence.

Career and Major Work

Beginning of Artificial Intelligence

After brief spells as a professor at both Princeton and Stanford, McCarthy joined Dartmouth College in 1955 as an assistant professor. Here he was involved in organising the first ever research project on a subject which he coined “artificial intelligence”. The topics to be discussed during this 2-month long project included neural nets, automatic programming, and incorporating randomness and creativity into a machine. McCarthy had become interested in artificial intelligence (AI) after attending a conference on “Cerebral Mechanisms in Behaviour” where speakers including John Von Neumann and Alan Turing inspired him to begin the quest of getting computers to think like humans. McCarthy believed that if human intelligence could be understood fully, then it would be possible to replicate this intelligence in a machine. After a brief spell at Dartmouth College, McCarthy joined M.I.T. where he set up an AI research lab with a fellow researcher named Marvin Minsky.

The Advice Taker

In 1958, in a paper titled “Programs with Common Sense”, McCarthy proposed a hypothetical computer program known as the advice taker. This paper suggested using logic to represent information in a computer. McCarthy believed that in order to be considered intelligent, a machine must be able perform common sense reasoning as effortlessly as

humans. The goal of this logic-based program was to be able to get computers to “manipulate in a suitable formal language (most likely a part of the predicate calculus) common instrumental statements”. The paper is thought to be the first paper to suggest common sense reasoning as the key to artificial intelligence. However, at the time the paper was criticized by many who believed that McCarthy’s ideas were too simplistic. These critics noted that reasoning with common-sense knowledge was more complicated than McCarthy had suggested. The human decision-making process expands far beyond simple logic-based reasoning. Much of this criticism is still valid for artificial intelligence today. One notable example of this problem has arisen in autonomous driving, where it is almost impossible to simulate every possible situation and decision that a human driver faces. This problem has manifested itself in numerous accidents over the last couple of years, in which autonomous or semi-autonomous vehicles failed to respond appropriately to stationary objects such as parked cars.

Timesharing and Utility Computing

In the late 1950s, John McCarthy played a major part in the first ever project to implement a process known as timesharing. This process involved the sharing of a single computer among many users through multi-programming and multi-tasking. Timesharing allowed many users to interact concurrently with a single computer and thus saved time and money, as individuals could use a computer without owning one. The result of this project was a system known as the Compatible Time-Sharing System (CTSS) and was first demonstrated in 1961. The concept of timesharing paved the way for the creation of the internet, which at its core is dependent on timesharing systems, and is one of the major underpinnings of cloud-computing. Speaking at an M.I.T centennial in 1961, McCarthy also alluded to the idea of utility computing, suggesting that the CTSS or a similar shared computing resource could one day be sold as a utility, i.e. people would pay a fee based on usage of such a system. Although the idea of utility computing had died down by the 1990s, the 2000s has seen a resurgence of similar conceptual ideas, namely cloud and grid-computing.

Lisp

In 1958 McCarthy began designing a programming language called Lisp. At the time, almost all programming was done in assembly language, with the exception of FORTRAN which first appeared in 1957. However, FORTRAN was primarily focused on performing numerical calculations. As artificially intelligent systems were required to manipulate non-numerical data, McCarthy decided to develop a list processing language, which he named Lisp. Lisp was based on the idea of Lambda Calculus, which is a formal system in mathematical logic used to express computations based on function abstraction and the evaluation of symbolic expressions rather than numbers. McCarthy published Lisp in 1960, in a paper titled “Recursive Functions of Symbolic Expressions and their Computation by Machine (Part I)”. Lisp was the first language to incorporate many elements of functional programming, although it was not a purely functional language. It quickly became the main language used in the programming of systems in the field of artificial intelligence. The Lisp language pioneered many concepts now prevalent in most high-level programming languages. These concepts include dynamic typing, conditional statements, recursion, tree data structures, as

well as the idea of garbage collection. Variations of the Lisp language remained popular up until the 1990s. However, in recent years, the language has experienced a resurgence in popularity, with many open source Lisp communities emerging.

Garbage Collection

In 1959, whilst developing Lisp, McCarthy invented a process known as “garbage collection”. McCarthy invented the garbage collection process to simplify manual memory management in Lisp. The garbage collection process invented by McCarthy sought to find registers which were no longer reachable in a program, through depth-first search, and recycle these registers, freeing up memory for the creation of more registers. A garbage collection sweep would only occur once all available memory had been used up. Today many languages including Java, Ruby, and Haskell have in-built garbage collection systems which are based on McCarthy’s original idea of reclaiming the memory used up by variables which are no longer needed or used in a program.

Stanford University and Further Exploration of Artificial Intelligence

In 1962 after a divergence of thought between himself and Marvin Minsky, McCarthy left M.I.T and joined Stanford as a professor of mathematics. A year later he joined the Computer Science department at Stanford where he would spend the rest of his working life. In 1965, McCarthy set up an AI research lab at Stanford to rival the lab he had set up with Minsky at M.I.T. Over the next 50 years, this AI lab would be involved in cutting-edge work on robotics, speech processing, and knowledge representation, all of which stemmed from the field of artificial intelligence, which McCarthy had coined in 1956 at Dartmouth College. Soon after setting up the AI research lab at Stanford, McCarthy was involved in creating a chess-playing computer program, which competed against a similar program developed by researchers in the Soviet Union.

In 1976 McCarthy was awarded the ACM Turing award for his contributions to the field of artificial intelligence. Other notable winners of this award include McCarthy’s old colleague Marvin Minsky, Edsger Dijkstra, Donald Knuth, Robert Floyd, and more recently Tim Berners-Lee, who invented the World Wide Web.

Between 1976 and 1986 McCarthy published a series of papers describing the circumscription of non-monotonic reasoning, which formalized the common-sense assumption of things being as expected unless otherwise specified. Other notable papers published by McCarthy throughout the rest of his career include "Generality in artificial intelligence" (1990), "Notes on formalizing context" (1993), and “Elaboration Tolerance” (1998).

Retirement and Legacy

John McCarthy retired from his role at Stanford in 1994 but continued to carry out research and publish papers on mathematics and artificial intelligence up until his death in 2011. McCarthy will be remembered by the fields of Computer Science and Artificial Intelligence as an incredibly gifted individual and inventor, whose influence in the areas of software engineering, computer science, and artificial intelligence will likely be felt forever. McCarthy

was also incredibly generous with his time, having helped numerous colleagues throughout his career, as well as helping more than thirty students achieve their PhDs while at Stanford University.

Personal Life

John McCarthy was married three times throughout his life. His second wife was a computer programmer and mountaineer who died on an expedition in 1978. McCarthy's third wife was a computer scientist at Stanford University, where McCarthy himself worked for most of his life. McCarthy considered himself an atheist. On 24 October 2011, McCarthy died at his home in Stanford at the age of 84.

Major Honours and Awards

- The Turing Award from the Association for Computing Machinery (1971).
- Kyoto Prize (1988).
- National Medal of Science (USA) in Mathematical, Statistical, and Computational Sciences (1990).
- Benjamin Franklin Medal in Computer and Cognitive Science from the Franklin Institute (2003).
- Inducted into IEEE Intelligent Systems' AI's Hall of Fame (2011), for "significant contributions to the field of AI and intelligent systems".
- Named as a Stanford Engineering Hero (2012).

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