John McCarthy (1927-2011)

John McCarthy introduced the term “artificial intelligence” to identify his principal interest and created the LISP programming language to help develop that field. He also initiated the mathematical theory of computation and the development of computer timesharing, which turned out to be a necessary precursor of the internet.

John McCarthy was born September 4, 1927 in Boston, Massachusetts to immigrant parents. His father, John Patrick McCarthy, was an Irish Catholic who became a labor organizer and later the Business Manager of the *Daily Worker*, a national newspaper owned by the Communist Party USA. His mother, Ida Glatt, was a Lithuanian Jewish immigrant who worked for a wire service, was then a labor organizer and also worked for the *Daily Worker* and finally as a social worker.

Caltech, Princeton and Stanford

The family moved to New York City but John was a sickly child and his parents then took him to Los Angeles for his health. There he began reading books on mathematics at the nearby California Institute of Technology (Caltech) and when he was admitted there as an undergraduate in 1944 he was given advanced standing. However he then was suspended for failing to attend physical education classes and spent some time in the U.S. Army but still managed to graduate in 1948.

After a year of graduate studies at Caltech he went to Princeton and received a PhD in mathematics in 1951 based on a dissertation that solved a problem in partial differential equations. He taught there until 1953, when he became an assistant professor of mathematics at Stanford until 1955. He co-edited a book with Claude Shannon titled *Automata Studies* [11].

Dartmouth and Artificial Intelligence

His work has emphasized epistemological problems, i.e., the problems of what information and what modes of reasoning are required for intelligent behavior. Given that McCarthy was primarily a mathematician and technologist who had little use for puffery it is ironic that his most widely recognized contribution turned out to be in the field of marketing, specifically in choosing a brand name. Having noticed that the title of the *Automata Studies* book didn't stir up much excitement, when he subsequently moved to Dartmouth College he introduced the name *artificial intelligence* at a 1956 conference there [3] and saw that it was subsequently embraced both by people working in the field and the general public.

MIT and Timesharing

Moving on to the Massachusetts Institute of Technology (MIT) in 1958, he and Marvin Minsky formed an Artificial Intelligence Project there, where much pioneering work took place in a wide range of fields, from robotics to theory of computation to common sense reasoning [4] to human-computer interfaces. McCarthy also created the LISP (LISt Processing) language [1], the second oldest high level language, after FORTRAN. It became the most widely used language in artificial intelligence research and is still widely used. He also made substantial contributions to the algebraic languages ALGOL 58 and 60.

McCarthy's students developed the first computer program to play chess convincingly. It ran initially on an IBM 704 computer and incorporated McCarthy's alpha-beta pruning scheme to reduce the number of positions that had to be considered.

In this period McCarthy observed the nearby development of the SAGE air defense system, which had been initiated by a computer group at MIT and included timesharing support for many concurrent users at large screen displays with point-and-click interfaces. He wanted to use interactive computing in his research but SAGE was a special purpose system that did not support interactive program development. He then came up with a scheme for creating general purpose timesharing and described it in a memorandum [5]. His approach inspired a number of groups in the MIT community to build such systems.

The first demonstration system, called CTSS, was developed by Prof. Fernando Corbato and his colleagues and began operating in June 1962. McCarthy concurrently developed another timesharing system through his consultancy at Bolt Beranek and Newman (BBN) with J.C.R. Licklider and Edward Fredkin and it began working a few months later. CTSS led directly to the creation of Project MAC, which revolutionized computing at MIT and inspired the switch to timesharing systems in many places.

Stanford and ARPAnet

General purpose timesharing was an essential precursor to computer networking. The first general purpose computer network, created exclusively as a network of timesharing systems, was called ARPAnet and was conceived by J.C.R. Licklider, then specified by Dr. Lawrence Roberts and a group of academics who wanted to be able to collaborate by sharing resources and ideas. It was funded by the Advance Research Projects Agency (ARPA), constructed by BBN and became operational around 1970. Its successor, the internet, has always depended on timesharing systems at its heart, which came to be called “servers” and in recent years have been re-branded as “cloud computing.” All of that likely would have been delayed if McCarthy had not instigated timesharing system development in the early 1960s.

In late1962 McCarthy left MIT to return to Stanford University’s mathematics department as a full professor and started a new Artificial Intelligence Project there, which was soon funded by the Defense Department’s Advanced Research Projects Agency (ARPA, later called DARPA). He also initiated the development of the first display-based timesharing system, called Thor [6], which included many of the features found in modern personal computers and subsequently was used by others in the development of computer-aided instruction systems.

A turn to the right

Having been raised by Communist parents, McCarthy became interested in the Soviet Union and developed friendships with several computer scientists there. He also learned to speak Russian and visited the Soviet Union a number of times and in doing so became aware of the human rights violations of that regime. He then began taking an active role in support of the human rights of computer

professionals and over time moved further away from Communist ideas. Vera Watson, his second wife, was the daughter of Russian missionaries living in China and she helped him move further to the right until he became a conservative Republican. Unfortunately she died in a climbing accident in Nepal while trying to ascend Annapurna.

McCarthy also continued to develop his chess program and in 1965 he challenged a group at the Moscow Institute for Theoretical and Experimental Physics (ITEP) to a match with their program. Moves were exchanged by telegraph and received substantial media attention but neither program did very well and the Russian program won. McCarthy attributed this more to Russian strength in chess rather than their strength in computer science. The cryptic telegraphic exchanges were reportedly noticed by the Russian KGB security authorities, who investigated.

In 1968 McCarthy bet International Chess Master David Levy $1,000 that a computer would be world champion within ten years. He had to pay that one, though a computer did eventually beat the world champion in 1997.

McCarthy always loved to hear about new ideas in almost any field and generated many of them himself. He also acquired all new high tech devices to see what he could do with them. He continued his work on mathematical theory of computation and on developing programs with common sense including formalization of non-monotonic reasoning whereby people and computers draw conjectural conclusions by assuming that complications are absent from a situation [4, 9].

SAIL

In 1965 the Stanford Computer Science Department had spun off from Mathematics and McCarthy's support from ARPA greatly increased to include a million dollar computer facility. He then recruited Lester Earnest as executive officer to help put together the new facility. Together they initiated or invited in a diverse set of research projects to use the new computer facility when it became available in mid-1966 using a DEC PDP-6 timesharing system and later a KA-10 computer.

McCarthy's former student Raj Reddy, who did pioneering work in speech understanding, accepted a Stanford faculty appointment and scaled up that project. A music graduate student named John Chowning put together a computer music project and earned a faculty appointment. That project became a world leader in its field and eventually spun off as the Center for Computer Research in Music and Acoustics (CCRMA).

Following up on McCarthy's interest in robotics, Lester Earnest initiated a so-called hand-eye project that used visual information from a video camera to

guide a robotic arm in doing assembly tasks, a project that was taken over by Jerome Feldman, a new faculty member. Ultimately, it led to the Robotics Institute at Carnegie Mellon under the direction of Raj Reddy when he moved there. Earnest also put together a robot vehicle with the goal of guiding it by visual information from a video camera and McCarthy took that over. However the performance of that system turned out to be severely limited by the computer processing speeds then available.

Dr. Kenneth Colby brought in his Higher Mental Functions project that developed a conversational model of a paranoid called Parry and also developed a computer interface that helped autistic children.

In 1971 SAIL apparently became the first computer facility anywhere in the world to put display terminals on everyone's desk. Those terminals also provided access to various video cameras in the laboratory and to live television, which encouraged football fans to work on Saturdays and Sundays.

Concurrently a small group of graduate students led by David Poole and Phil Petit were given support to develop SUDS (Stanford University Drawing System), the first display-based computer aided design system for digital systems, which they used to design a new computer that became the DEC KL-10. SUDS produced artwork for printed circuit cards and instructions for back panel wiring machines to facilitate automatic production. It became the primary design tool of Digital Equipment Corporation and a number of other corporations for many years.

By the early 1970s McCarthy had begun to think about the potential of networks of personal computers in the home and presented a paper on "The Home Information Terminal" [7]. Given that the diversity of projects had greatly expanded [8], in 1972 Earnest suggested changing the name of the facility to Stanford Artificial Intelligence Laboratory (SAIL) and McCarthy concurred.

Vint Cerf's development at Stanford of the TCP/IP protocols, upon which the internet was based, was supported by the same DARPA contract that supported SAIL. Over time SAIL produced many able PhDs and other graduates and became a hotbed of entrepreneurial activity that produced dozens of corporate spinoffs, both direct and indirect, included Microsoft, Sun Microsystems, DE Shaw & Co., Amazon.com, Cisco Systems and Yamaha's music synthesizer business. All of that was enabled by the diversity of SAIL projects that shared facilities and ideas.

Over time sixteen ACM Turing Awards have been given to people who had been affiliated with SAIL.

John McCarthy nominally retired at the end of 2000 but remained very active in developing new ideas and documenting them. He passed away at age 84 at his

Stanford home on 24 October 2011. He is survived by his first wife, Martha Coyote, and their two daughters Susan and Sarah McCarthy and his third wife, Carolyn Talcott, and their son Timothy McCarthy.

References

[1] Levin, Michael. *Lisp 1.5 Programmers Manual*. Cambridge, Massachusetts: MIT Press, 1965. The most widely used programming language for artificial intelligence research.

[2] Lifschitz, Vladimir (ed.). *Artificial Intelligence and Mathematical Theory of Computation*, Papers in Honor of John McCarthy. San Diego: Academic Press, 1991. Covers much of John McCarthy's pioneering research.

[3] McCarthy, John, M.L. Minsky, N. Rochester, C.E. Shannon, "A proposal for the Dartmouth summer conference on artificial intelligence," Conference Announcement, 31 Aug. 1955.

[4] McCarthy, John. "Programs with Common Sense." Proc. Teddington Conference on the Mechanization of Thought Processes, 1958. His earliest work on this AI topic.

[5] McCarthy, John, "A Time Sharing Operator Program for our Projected IBM 709", Memorandum to Professor P.M. Morse, Jan. 1, 1959. This memo initiated the development of timesharing systems, which ultimately made the internet possible.

[6] McCarthy, John, et al, "Thor--a display based time sharing system," Proc. AFIPS Conf. 1967. The first display-based general purpose timesharing system.

[7] McCarthy, John. "The Home Information Terminal." Man and Computer, Proc. Int. Conf., Bordeaux 1970, pp. 48-57. Basel: Karger, 1972. Anticipated the usefulness of computer access from the home, much of which would not be realized until the appearance of networked personal computers in the early 1980s.

[8] McCarthy, John, Edward Feigenbaum, Joshua Lederberg, "The first ten years of artificial intelligence research at Stanford," Computer Science Department Report STAN-74-409, Stanford University, July 1973. Reviews the diverse set of projects that found a home in SAIL.

[9] McCarthy, John. "Applications of Circumscription to Formalizing Common Sense Knowledge." *Artificial Intelligence*, April 1986. A key development in formalized common sense reasoning.

[10] McCarthy, John and Vladimir Lifschitz (ed.). Formalization of Common Sense, papers by John McCarthy. Norwood, New Jersey: Ablex, 1990. More on common sense reasoning.

[11] Shannon, Claude, and John McCarthy (eds.). *Automata Studies.* Princeton: Princeton University Press, 1956. McCarthy's first large work on what he later called artificial intelligence.

Biography

Birth: 4 September 1927, Boston, Massachusetts
Death: 24 October 2011, Stanford, California

Education:
1948 BS mathematics, California Institute of Technology
1951 PhD mathematics, Princeton University

Experience:
1945-46 Private, U.S. Army
1951-53 Instructor in mathematics, Princeton University
1953-55 Assistant Professor of mathematics, Stanford University
1955-58 Assistant Professor of mathematics, Dartmouth College
1958-62 Assistant Professor of communication science, Massachusetts Institute of Technology
1962-65 Professor of mathematics, Stanford University
1965-2011 Professor of computer science, Stanford University
1966-80 Director of the Stanford Artificial Intelligence Laboratory

Honors & Awards:
Received the A.M. Turing Award of the Association for Computing Machinery, 1971. Member of the National Academy of Engineering (1987) and National Academy of Sciences, 1989. Research Excellence Award of the International Conference on Artificial Intelligence, 1985. Kyoto Prize,1988. National Medal of Science,1990. Received many other honors and prizes from international associations and universities as well as from the United States government,