Arthur Lee Samuel

Born 1901, Emporia, Kan.; died July 29, 1990, Menlo Park, Calif.; pioneer in machine learning.

Education: BS, College of Emporia; MS, MIT, 1926; graduate work, physics, Columbia University.

Professional Experience: instructor, electrical engineering, MIT, 1926-1928; Bell Telephone Laboratories, 1928-1946; professor, electrical engineering, University of Illinois, 1946-1949; IBM, 1949-1966; Stanford University: lecturer and research associate, 1966-1982.

Honors and Awards: IEEE Computer Society Pioneer Award, 1987; fellow, Institute of Electrical and Electronic Engineers; fellow, American Physical Society; fellow, Institute of Radio Engineers; fellow, American Institute of Electrical Engineers; DSc (Hon.), College of Emporia.

Professor Emeritus Arthur L. Samuel died July 29, 1990, at Stanford Hospital from complications related to Parkinson's disease.[1] A pioneer of artificial intelligence research (best known for his program that played championship level checkers), his life spanned a period of broad scientific advancement. Arthur Samuel was born in 1901 in Emporia, Kansas. He graduated from the College of Emporia, and while also working intermittently at General Electric Company in Schenectady, he went on to earn a Master of Science degree from MIT in 1926. He later did graduate work in physics at Columbia University. In 1946 the College of Emporia awarded him an honorary doctorate.

After his master's degree he stayed on at MIT as an instructor in electrical engineering until 1928, when he joined Bell Telephone Laboratories. At “Bell Labs” he worked mainly on electron tubes. Particularly notable was his work on space charge between parallel electrodes, and his wartime work on TR-boxes, switches that disconnect the receiver of a radar when it is transmitting and prevent the sensitive receiver from being destroyed by the high power transmitter.

In 1946 Samuel became professor of electrical engineering at the University of Illinois, and was active in their project to design one of the first electronic computers. It was there he conceived the idea of a checkers program capable of beating the world champion, to demonstrate the power of electronic computers. Apparently the program was not finished while he was at the University of Illinois, perhaps because the computer was not finished in time.

In 1949 Samuel joined IBM's Poughkeepsie Laboratory. This move was seen by IBM's competitors as a commitment by IBM to vacuum tube-based computing. However, as his autobiography describes it, he had to fulfill a dual role there: pushing research on switching transistors and keeping engineers going with the available tube technology. Tubes were used for logic and memory in IBM's first stored program computer, the 701. The memory was based on Williams tubes, which stored bits as charged spots on the screen of a cathode ray tube. Samuel managed to increase the number of bits stored from the customary 512 to 2,048 and to raise

[1] From Tajnai 1991.

the mean time to failure to half an hour. Memory capacities of those machines eventually grew to 8K words. He completed the first checkers program, apparently the world's first self-learning program, on the 701. When it was about to be demonstrated, Thomas J. Watson, Sr., the founder and president of IBM, remarked that the demonstration would raise the price of IBM stock 15 points. It did.

The Samuel Checkers-Playing Program is a very early example of a method now commonly used in artificial intelligence (AI) research, that is, to work in a complex yet understandable domain. Programs for playing games fill the role in AI research that the fruit fly (drosophila) plays in genetics. Drosophilae are convenient for genetics because they breed quickly, and games are convenient for AI because it is easy to compare computer performance with that of people.

Samuel took advantage of the fact that the checker players have access to many volumes of annotated games with the good moves distinguished from the bad ones. Samuel's learning program replayed the games presented in *Lee's Guide to Checkers* to adjust its criteria for choosing moves so that the program would choose as often as possible those moves thought good by checker experts.

In 1961, when Ed Feigenbaum and Julian Feldman were putting together the first AI anthology *(Computers and Thought),* they asked Samuel to give them, as an appendix to his splendid paper on his checker player, the best game the program had ever played. Samuel used that request as an opportunity to challenge the Connecticut state checker champion, the number-four-ranked player in the nation. Samuel's program won. The champion provided annotation and commentary to the game when it was included in the volume.

Because his checkers work was one of the earliest examples of nonnumerical computation, Samuel greatly influenced the instruction set of early IBM computers. The logical instructions of these computers were put in at his instigation and were quickly adopted by all computer designers because they are useful for most nonnumerical computation.

Samuel was a modest man, and the importance of his work was widely recognized only after his retirement from IBM in 1966. He did not relish the politics that would have been required to get his research more vigorously pursued. He was also realistic about the large difference between what had been accomplished in understanding intellectual mechanisms and what will be required to reach the level of human intelligence.

Samuel's papers on machine learning are still worth studying. With great creativity and working essentially alone, doing his own programming, he invented several seminal techniques in rote learning and generalization learning, using such underlying techniques as mutable evaluation functions, hill climbing, and signature tables. One still hears proposals for research in this area less sophisticated than his work of the 1950s. Besides engineering and computer science, Samuel did important management work at IBM. He played a large role in establishing IBM's European laboratories and setting their research directions, especially in Vienna and Zurich. (The Vienna Laboratory did important work in computer language specifications and the Zurich Laboratory in physics, leading to several Nobel prizes.) He became the editor of the influential *IBM Journal of Research and Development.*

Samuel retired from IBM in 1966 and went to Stanford University as a lecturer and research associate, starting yet another life. In 1974 he became a research professor there. He continued his work on checkers until his program was outclassed. He also worked on, speech recognition until the funding agency decided to concentrate

its speech work on developing a single approach. Samuel was actively teaching up to 1982. He supervised several PhD theses at Stanford.

Arthur Samuel remained an active computer programmer long after age forced him to give up active research. His contributions included work on the SAIL operating system, on software for the Livermore S-1 multiprocessor, and on the TEX typesetting system. His last work, continued up to the age of 86, involved modifying programs for printing in multiple type fonts on some of the Stanford Computer Science Department's computers. We believe he was the world's oldest active computer programmer. The Stanford computer he used tells us that he last logged into it on February 2, 1990, and his home computer was still used throughout the summer.

One of Samuel's talents was understanding inadequate documentation of complicated programs and writing clear and attractive manuals. In 1989 his *First Grade TEX* was translated into Japanese. He started an autobiography, which, unfortunately, takes us only to the middle 1960s.

Arthur Samuel was a fellow of the Institute of Electrical and Electronic Engineers, the American Physical Society, the Institute of Radio Engineers, and the American Institute of Electrical Engineers, and a member of the Association for Computing Machinery and the American Association for the Advancement of Science.

As a person, Samuel was distinguished by his objectivity and his kindness in helping people, especially in sharing his knowledge.

BIBLIOGRAPHY

Biographical

Tajnai, Carolyn E. “Samuel Was Artificial Intelligence Pioneer,” *Computing Research News,* Jan. 199 1.

Weiss, Eric, “Arthur Samuel,” *Ann. Hist. Comp.,* Vol. 14, No. 3,1992, pp. 55-68.

Significant Publications

Samuel, A.L., “Artificial Intelligence: A Frontier of Automation,” *Ann. American Acad. Political and Social Science,* Vol. 340, Mar. 1962, pp. 10-20.

Samuel, Arthur L., “Some Studies in Machine Learning Using the Game of Checkers,” in Feigenbaum, Edward A., and Julian Feldman, eds., *Computers and Thought,* McGraw-Hill, New York, 1983, pp. 71-105.

UPDATES

Portrait added (MRW, 2013)