Marvin L. Minsky

(1927–2016)

A founding father of artificial intelligence.

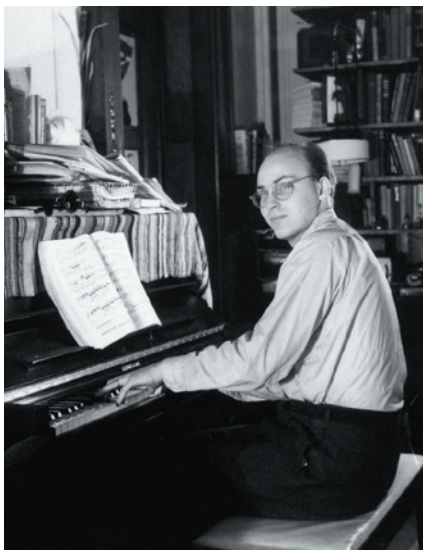
Marvin Lee Minsky had no patience for those who doubted that computers could be intelligent at a human level or beyond. In the late 1950s, building on the work of Alan Turing, along with computer scientists John McCarthy, Herbert Simon and Allen Newell, Minsky started the work that led everyone to think of this group as the founders of the field of artificial intelligence (AI). Were it not for their determined advocacy, AI might have foundered.

Minsky, who died on 24 January, was born in New York City in 1927. After serving in the US Navy in the Second World War, he earned a degree in mathematics in 1950 from Harvard University in Cambridge, Massachusetts, where he impressed the mathematician Andrew Gleason by proving fixed-point theorems in topology. During his doctorate on learning machines, at Princeton University in New Jersey, he built one out of vacuum tubes and motors.

When Minsky finished his PhD, the eminent mathematicians John von Neumann, Norbert Wiener and Claude Shannon all recommended him for appointment as a junior fellow at Harvard. During this time, he became curious about how the brain works, but was frustrated by the limitations of conventional microscopy, which could not provide clear images of thick, light-scattering neural tissue. This led to his invention of the confocal scanning microscope, which uses lenses to focus light on successively small volumes.

In the late 1950s, with McCarthy, he founded a group that became the Artificial Intelligence Laboratory at the Massachusetts Institute of Technology (MIT) in Cambridge. In 1961, Minsky published his famous paper 'Steps toward artificial intelligence' (M. Minsky *Proc. IRE* **49,** 8–30; 1961), a call to arms for a generation of researchers. Scientists flocked to Minsky's laboratory to take on the challenge of understanding intelligence and endowing computers with it. They benefited from Minsky's wisdom and enjoyed his insights, lightning-fast analyses and impish repartee.

His students felt part of a scientific revolution. They helped Minsky to develop high-level theories about how programs could recognize structures made of toy blocks, answer questions about stories written for children, learn something definite from individual examples and exhibit common sense.



COURTESY OF MINSKY FAMILY

His laboratory was an egalitarian utopia. He didn't notice looks, gender, age or status. He cared only about ideas and ability. Minsky and his wife, Gloria, often welcomed students into their home, where several pianos stood as a reminder that Minsky was a musical prodigy, able to improvise fugues.

Minsky's attention span was short. Whenever I explained an idea to him, he would leap ahead of me, having worked the whole thing out after a few sentences. Once, I suggested that if we ever developed really intelligent machines, we should do a lot of simulation before we let them loose in our world to be sure they weren't dangerous. "And we're the simulation?" he said, guessing my punchline. "It isn't going very well, is it?"

His laboratory built pioneering robots as well as revolutionary programs. Minsky invented a robot arm with 14 degrees of freedom. He argued that space exploration and nuclear-material processing would be simpler with manipulators driven locally by computers or remotely by human operators. He foresaw that microsurgery would be done by surgeons by using telepresence systems.

In the late 1960s, Minsky and MIT mathematician Seymour Papert worked on the mathematics of perceptrons — simple neural networks — showing what they could and could not do, which raised the sophistication of research on neurally inspired mechanisms to a higher level. Minsky and Papert collaborated into the 1970s and early 1980s, developing theories of intelligence and radical approaches to early education that centred on teaching children to program using the Logo language.

In the mid 1970s, Minsky introduced 'frames', a way of describing entities and situations using a template-like representation. A frame describing a birthday party, for example, would have a slot for the person celebrated, that person's age and a list of the gifts presented, along with slots for time and place inherited from a 'celebration' frame. He also developed the idea of knowledge lines (K-lines) to address questions about how information is represented, stored, retrieved and used in the brain. He argued that K-lines help us to solve problems by putting us back into mental states that resemble those we were in when we previously thought about similar problems.

In 1985, he brought these and many other ideas together in a book, *The Society of Mind* (Simon & Schuster). He wrote that intelligence emerges from the cooperative behaviour of multiple agents, none of which is intelligent. Then, in 2006, Minsky published *The Emotion Machine* (Simon & Schuster), a book about intelligence, creativity, emotion, consciousness and common sense. Multiplicity is a dominant theme. He noted, for example, that concepts such as intelligence are 'suitcase words', into which one can stuff multiple meanings. He wrote that our resourceful intelligence arises from multiple ways of thinking on multiple levels, and from multiple ways of representing knowledge.

In recent years, Minsky found it ironic that the doubters of the possibility of AI have been replaced by worriers about its consequences. He didn't see a technical advance that would justify the change in attitude, attributing recent successes in AI to faster computers. He thought that not much real progress had been made in the field for several decades, but he had, nevertheless, no doubt that our species' greatest legacy will be the intelligent computers that we create.

Minsky's talks, papers and books are like diamond mines. The riches will take decades to cut and polish, inspiring researchers for decades to come. ■

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