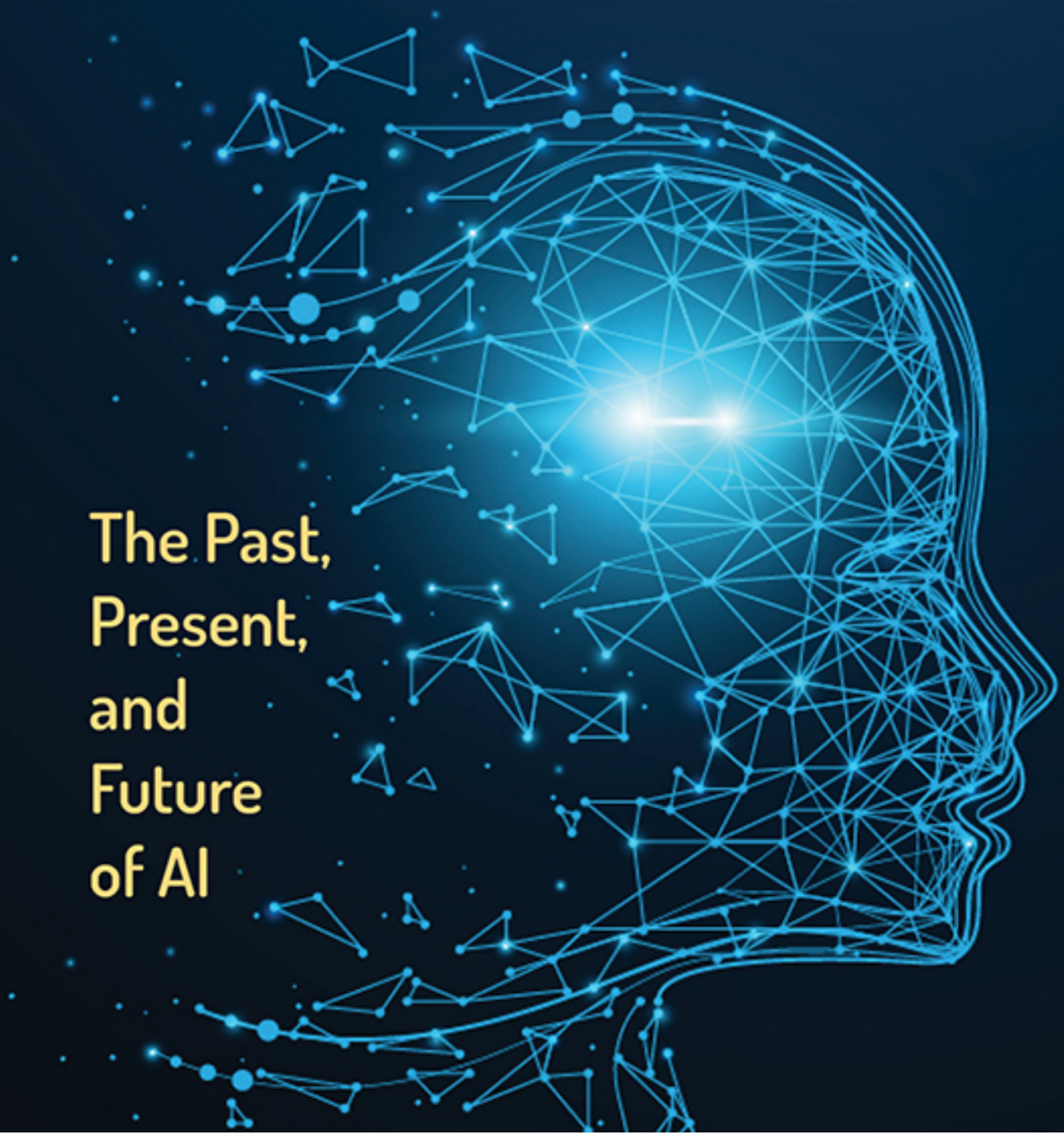
PHILIP L. FRANA AND MICHAEL J. KLEIN, EDITORS

ENCYCLOPEDIA OF ARTIFICIAL INTELLIGENCE



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recipient of the National Science Foundation CAREER Award, the Association for Women in Science Chicago Innovator Award, and Mentor of the Year at UIC.

Philip L. Frana

See also: Deep Learning.

Further Reading

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Berserkers

Berserkers are a fictional type of intelligent killer machines first introduced by science fiction and fantasy author Fred Saberhagen (1930–2007) in a 1962 short story, "Without a Thought." Berserkers subsequently appeared as common antagonists in many more novels and stories by Saberhagen.

Berserkers are an ancient race of sentient, self-replicating, space-faring machines programmed to destroy all life. They were created in a long-forgotten interstellar war between two alien races, as an ultimate doomsday weapon (i.e., one intended as a threat or deterrent more than actual use). The details of how they were unleashed in the first place are lost to time, as the Berserkers apparently wiped out their creators along with their enemies and have been marauding the Milky Way galaxy ever since. They range in size from human-scale units to heavily armored planetoids (cf. Death Star) with a variety of weapons powerful enough to sterilize planets.

The Berserkers prioritize destruction of any intelligent life that fights back, such as humanity. They build factories to replicate and improve themselves, while never changing their central directive of eradicating life. The extent to which they undergo evolution is unclear; some individual units eventually deviate into questioning or even altering their goals, and others develop strategic genius (e.g., *Brother Assassin*, "Mr. Jester," *Rogue Berserker*, *Shiva in Steel*). While the Berserkers' ultimate goal of destroying all life is clear, their tactical operations are unpredictable due to randomness from a radioactive decay component in their cores. Their name is thus based on the Berserkers of Norse legend, fierce human warriors who fought with a wild frenzy.

Berserkers illustrate a worst-case scenario for artificial intelligence: rampant and impassive killing machines that think, learn, and reproduce. They show the perilous hubris of creating AI so advanced as to surpass its creators' comprehension and control and equipping such AI with powerful weapons, destructive intent,

and unchecked self-replication. If Berserkers are ever created and unleashed even once, they can pose an endless threat to living beings across vast stretches of space and time. Once unbottled, they are all but impossible to eradicate. This is due not only to their advanced defenses and weapons but also to their far-flung distribution, ability to repair and replicate, autonomous operation (i.e., without any centralized control), capacity to learn and adapt, and infinite patience to lie hiding in wait. In Saberhagen's stories, the discovery of Berserkers is so terrifying that human civilizations become extremely wary of developing their own AI, for fear that it too may turn on its creators. However, some clever humans discover an intriguing counter weapon to Berserkers: Qwib-Qwibs, self-replicating machines programmed to destroy all Berserkers rather than all life ("Itself Surprised" by Roger Zelazny). Cyborgs are another anti-Berserker tactic used by humans, pushing the boundary of what counts as organic intelligence (*Berserker Man, Berserker Prime, Berserker Kill*).

Berserkers also illustrate the potential inscrutability and otherness of artificial intelligence. Even though some communication with Berserkers is possible, their vast minds are largely incomprehensible to the intelligent organic lifeforms fleeing from or fighting them, and they prove difficult to study due to their tendency to self-destruct if captured. What can be understood of their thinking indicates that they see life as a scourge, a disease of matter that must be extinguished. In turn, the Berserkers do not fully understand organic intelligence, and despite many attempts, they are never able to successfully imitate organic life. They do, however, sometimes recruit human defectors (which they call "goodlife") to serve the cause of death and help the Berserkers fight "badlife" (i.e., any life that resists extermination). Nevertheless, the ways that Berserkers and humans think are almost completely incompatible, thwarting efforts toward mutual understanding between life and nonlife. Much of the conflict in the stories hinges on apparent differences between human and machine intelligence (e.g., artistic appreciation, empathy for animals, a sense of humor, a tendency to make mistakes, the use of acronyms for mnemonics, and even fake encyclopedia entries made to detect plagiarism). Berserkers are even sometimes foiled by underestimating nonintelligent life such as plants and mantis shrimp ("Pressure" and "Smasher").

In reality, the idea of Berserkers can be seen as a special case of the von Neumann probe, an idea conceived of by mathematician and physicist John von Neumann (1903–1957): self-replicating space-faring robots that could be dispersed to efficiently explore a galaxy. The Turing Test, proposed by mathematician and computer scientist Alan Turing (1912–1954), is also explored and upended in the Berserker stories. In "Inhuman Error," human castaways compete with a Berserker to convince a rescue team they are human, and in "Without a Thought," a Berserker attempts to determine whether or not its opponent in a game is human. Berserkers also offer a grim explanation for the Fermi paradox—the idea that if advanced alien civilizations exist we should have heard from them by now. It could be that Earth has not been contacted by alien civilizations because they have been destroyed by Berserker-like machines or are hiding from them.

The concept of Berserkers, or something like them, has appeared across numerous works of science fiction in addition to Saberhagen's (e.g., works by Greg Bear,

Gregory Benford, David Brin, Ann Leckie, and Martha Wells; the *Terminator* series of movies; and the Mass Effect series of video games). These examples all show how the potential for existential threats from AI can be tested in the laboratory of fiction.

Jason R. Finley and Joan Spicci Saberhagen

See also: de Garis, Hugo; Superintelligence; *The Terminator.*

Further Reading

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Biometric Privacy and Security

Biometrics, a term that comes from the Greek roots *bio* (meaning life) and *metrikos* (meaning to measure), involves statistical or mathematical methods to analyze data in the biological sciences. In recent years, the term has frequently been applied in a more specific, high-technology context to refer to the science of identification of individuals based on biological or behavioral characteristics and the artificial intelligence tools used to these ends.

The systematic measurement of human physical attributes or behaviors for purposes of later identification has been underway for centuries. The earliest documented use of biometrics is found in Portuguese historian Joao de Barros's (1496–1570) writings. De Barros documented how Chinese merchants used ink to stamp and record the hands and footprints of children. In the late nineteenth century, biometric techniques were introduced in criminal justice settings. In Paris, police clerk Alphonse Bertillon (1853–1914) began taking body measurements (the circumference of the head, length of fingers, etc.) of those in custody to keep track of repeat offenders, in particular individuals who frequently used aliases or changed aspects of their appearance to avoid recognition. His system became known as Bertillonage. It fell out of favor after the 1890s, when it became evident that many people had similar measurements. In 1901, Scotland Yard's Richard Edward Henry (1850–1931) developed a far more effective biometric system involving fingerprinting. He measured and classified loops, whorls, and arches and subdivisions of these elements on the tips of peoples' fingers and thumbs.

Fingerprinting remains one of the most common biometric identifiers used by law enforcement agencies worldwide. Fingerprinting systems are evolving alongside networking technology, taking advantage of massive national and international databases and computer matching.

The Federal Bureau of Investigation partnered with the National Bureau of Standards to automate fingerprint identification in the 1960s and 1970s. This involved scanning paper fingerprint cards already on file, as well as developing