Brain children

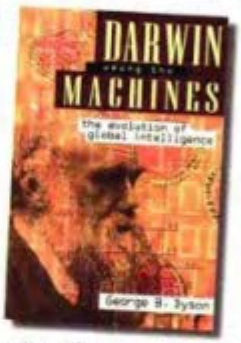
Humankind has been thinking about the thought process—and how to remake machines in its own image—for centuries. BY MARK WILLIAMS

Bots: The Origin of New Species
By Andrew Leonard
Hardwired
224 pages, $21.95

Darwin Among the Machines: The Evolution of Global Intelligence
By George B. Dyson
Addison-Wesley
288 pages, $25

In the beginning Pandemonium begat the IBM 7094 demon. And the MIT programmers saw it was good and said, Let there be Eliza the chatterbot. And Eliza begat Parry, the paranoid schizophrenic program, and gamebots. And gamebots begat MUDbots, which spread forth into the lands of IRC and Usenet, and there begat postingbots, mailbots, helpbots, spambots, cancelbots, and many others. Then were spiderbots begotten in the days of the Web: some of these were Webcrawler, Lycos, and Yahoo. Until it came to pass that there were search engines that searched only search engines, surveillance bots that disguised themselves as other surveillance bots to crack systems, rewritten BargainFinder bots that blocked access to online stores, and even bots incorporating algorithms to simulate mutation and natural selection. And their name was legion.

That's it, really. Andrew Leonard, the author of *Bots*, imposes genealogy on the autonomous programs inhabiting cyberspace—specious, but useful in tracing developments from MIT's first computer time-sharing program in 1963—and leavens that with inordinate amounts of Usenet trivia. He reports that programs capable of simulating conversation were embraced by apostles of artificial intelligence as evidence that true thinking machines were imminent. Subsequent lack of progress caused these theorists to regroup around concepts of neural nets and agents. Thus, programs are often endowed with anthropomorphic aspects: social interfaces for communicating with human users.



Homunculus sapiens

The best thing in *Bots* is University of Maryland computer scientist Ben Schneiderman, a savage critic of this philosophy: "For those who built stone idols or voodoo dolls or the golem or Frankenstein, it's long been a dream.... But no mature technology resembles [animal] form. Automobiles don't run with legs, and planes don't flap their wings. . . . You need to know that if you issue a command, you're going to get an exact and repeatable operation. . . . The data rates you can get by pointing, clicking, and dragging are a hundred to one-thousand times faster than natural language typing or voice." Anthropomorphized agents, Mr. Schneiderman finishes, are "things that think for people who don't."

Alas, there are plenty of those. Because human consciousness does have limited bandwidth, agents *could* mediate a world of endless information. Many functions—like telling the house to dim the lights—*would* be more easily done through speech-based interfaces. In fact, the day approaches when invisible servants will speak to us from the very air. Microsoft Bob was ridiculed, although it was only an experimental first step into the marketplace, hardly equivalent to pre-MS-DOS efforts. Office 97's cartoon Assistants are a clear advance. The Jesuits, no slouches at child programming, used to boast that if they were given a child before six, the adult was theirs for life. In October, as this review was written, Microsoft released an interactive Barney aimed straight at that preadolescent market. The same month, the company bought a $45 million stake in Lernout & Hauspie, a Belgium-based specialist in voice-enabled computing. (For more on speech-recognition technology, see "Talking the Talk," August, issue 45, page 40.) Every company aims to create customer attachment to its product, and anthropomorphized agents present unique possibilities for applying layers of seductive pseudointimacy: *You love it because it loves you!* Your Best Friend 6.0 (Microsoft Corporation).

Mr. Leonard is skittish about such speculation, which he calls "agent religion," ending his book with a coda about bots and agents having potential for both good and bad. Even for a volume this slim, that's not really enough. Leafing through the front, this reviewer noted that Mr. Leonard thanked the editor who helped transform "a column into a magazine story into a book." No gratitude to that editor is forthcoming here.

Digital prehistory

"Why do people like to think machines can't?" Disney's Marvin Minsky likes to ask. Samuel Butler (1835–1902) phrased the question more fully more than a century ago: "Why should not machines ultimately become as complicated as we . . . at

any rate complicated enough to be called living, and to be indeed as living as it was in the nature of anything at all to be?" Butler was the Victorian satirist who wrote *Erewhon*, which describes a hidden land whose inhabitants attempted to suspend history in order to prevent the evolution of machine intelligence. In 1863 he published an essay on the evolution of technology called "Darwin Among the Machines."

George B. Dyson takes Butler's title for his own book. Finding an audience may be difficult for a book that is *(a)* an account of the development of computers that is so revisionist its author feels compelled to take the *Leviathan* of Thomas Hobbes (1588–1679) as its starting point and *(b)* whose agenda is the depiction of that development as an evolution toward a Gaia-like global consciousness. But it would be a loss if Mr. Dyson's *Darwin Among the Machines* were dismissed as simply marketplace fodder in the genre, say, of Deepak Chopra meets the information age. The history he traces is surprising and wonderful.

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It's thrilling to discover that ideas have deeper historical lineages than one guessed and that the human minds that first conceived these ideas had more than an inkling of where they would lead. Hobbesian philosophy held that all thinking could be viewed as computation, that society constituted a distributed organism, that automata could have artificial life, and that mind was only the physical manifestations revealed by science. Gottfried Leibniz (1646– 716) developed binary calculus and proposed a binary calculating machine. André-Marie Ampère (1775–1836) pioneered game theory, advocated networks of electric telegraphs, and coined the word *cybernetique* a century before Norbert Weiner. Mr. Dyson weaves these figures and others into a digital prehistory persuasive enough to become the established version.

Butler: "We will say a great advance has been made in mechanical development when all men, in all places, without any loss of time, are cognizant . . . of all that they desire to be cognizant of in all other places, at a low rate of charge . . . the back country squatter may hear his wool sold in London and deal with the buyer himself—may sit in a chair in a back country hut and hear the performance of Israel in Aegypt at Exeter Hall—may taste an ice on the Rakaia, which he is paying for and receiving in the Italian Opera House at Covent Garden." Minus taste transmission, isn't this the Web?

Hello, Neumann

In particular, Mr. Dyson suggests that we haven't come to a full reckoning of John von Neumann (1903–1957). Mr. Dyson tells how, during his childhood at the Princeton Institute for Advanced Study—yes, he's Freeman Dyson's son—he and some playmates stumbled into a barn where remains of von Neumann's first computer were rusting. Mr. Dyson believes the success of the architecture that von Neumann advocated—a CPU operating sequentially; a distinction between hardware and software; hierarchical memory ranging from fast, limited RAM to slow, unlimited storage on floppy disks—has obscured his work on parallel processing, neural nets, and evolutionary computing.

Von Neumann will remain problematic. Quantum mechanics, pure logic and sets, economics, game theory, thermodynamics, nuclear reactions, meteorology, fluid dynamics, computers, self-reproducing automata—has another human being in history innovated across such a span, with such terrifying effectiveness? Always wearing three-piece suits, he circulated at the top levels of science and the Cold War military-industrial establishment, telling Oppenheimer, "I don't think any weapon can be too large" and advising preëmptive nuclear war with the slogan "Not whether, but

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when." Problematic, also, to guess where his work would have proceeded had he not died of cancer in his early 50s (after spending his last months in a Washington, D.C., hospital's private suite, with an air force colonel and eight airmen assigned by President Eisenhower to watch over him).

Von Neumann's formulations within quantum mechanics made him propose that it was *only* an observer's consciousness that collapsed pure quantum possibility into classical yes/no reality. Likewise, his thinking on computing moved in directions we haven't yet confronted. After his death, his work was distorted by those who promoted comparisons between computers and human brains; actually he'd been concerned with the *differences:* how something composed of 10 billion unreliable neurons functioned reliably and machines with 10,000 components constantly malfunctioned.

In *Probabilistic Logics and the Synthesis of Reliable Organisms from Unreliable Components,* written in 1956, the year before he died, von Neumann moved toward a model of mind as a system similar to those he'd explored in *Theory of Games and Economic Behavior.* Mr. Dyson writes, "He was laying the groundwork for a unified theory of information dynamics, applicable to free-market economies, self-reproducing organisms, neural networks, and . . . mind and brain." In that theory, sketched in notes and lectures before he died, "the human nervous system bears more resemblance to the statistically determined behavior of an economic system than to the precisely logical behavior of a digital computer."

Demonic shrieks

Pandemonium, an experiment proposed at MIT in 1958 and described in both *Bots* and *Darwin Among the Machines,* might provide a simple model of human thinking. Crudely simulating the many levels with which a cognitive system relates the data it receives, Pandemonium had four tiers: at bottom, data demons stored and transmitted data; next, computational demons performed operations and passed the results up; cognitive demons weighed the evidence and computed a shriek; the master demon responded to the loudest shrieks. Natural selection of processing demons occurred in the program, with those serving useful functions surviving and perhaps producing subdemons.

This process could work on broad scales. In 1960 a Rand Corporation memo titled "Reliable Digital Communications Systems Utilizing Unreliable Network Repeater Nodes" called for America's computers to be connected not by centralized switching centers but by individual switching nodes and the data packets themselves. Eventually this led to today's Internet. In such a large-scale system, what could provide the function served by the weighing, valuing demons in Pandemonium?

It would be a loss if 'Darwin Among the Machines' were dismissed as simply marketplace fodder in the genre, say, of Deepak Chopra meets the information age.

The human race has developed systems of pure valuation for thousands of years, of course. Economies are systems evolved to assign numerical values to tangible and intangible things. Mr. Dyson quotes the engineer who wrote that original Rand memo: "Probably the closest parallel structure to the Internet is the free-market economy." Money—especially digital currencies, which are electrons freighted with pure valuation, circulating globally—is analogous to the statistical coding that von Neumann hypothesized was the fault-tolerant language of biologically evolved neural nets. Money has the necessary self-reinforcing tendencies—it promotes architectural flexibility and feedback loops allowing systems to keep account. Hopefully, the human race is analogous to the decision-making master demon.

It puts a new spin on the ideas of all those people theorizing about the new economy and all those others warning that we worship the market like a god, doesn't it?

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