ALSO BY JOHN BROCKMAN

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How Things Are

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EDITED BY JOHN BROCKMAN

HARPER PERENNIAL

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"Where would you look for that?" asked Teller.

"I don't know."

"I do!"

"Where?"

"Globular clusters!" answered Teller. "We cannot get in touch with anybody else, because they choose to be so far away from us. In globular clusters, it is much easier for people at different places to get together. And if there is interstellar communication at all, it must be in the globular clusters."

"That seems reasonable," I agreed. "My own personal theory is that extraterrestrial life could be here already—and how would we necessarily know? If there is life in the universe, the form of life that will prove to be most successful at propagating itself will be digital life. It will adopt a form that is independent of the local chemistry and migrate from one place to another as an electromagnetic signal, as long as there's a digital world—a civilization that has discovered the Universal Turing Machine—for it to colonize when it gets there. And that's why von Neumann and you other Martians got us to build all these computers—to create a home for this kind of life."

There was a long, drawn-out pause. "Look," Teller finally said, lowering his voice, "may I suggest that instead of explaining this, which would be hard, you write a science-fiction book about it?"

"Probably someone has," I said.

"Probably," answered Teller, "someone has not."

COMPUTERS ARE THE NEW MICROSCOPES

TERRENCE SEJNOWSKI

TERRENCE SEJNOWSKI is a computational neuroscientist at the Salk Institute for Biological Studies and the co-author, with Patricia Churchland, of *The Computational Brain.*

Scientific ideas change when new instruments are developed that detect something new about nature. Electron microscopes, radio telescopes, and patch recordings from single-ion channels have all led to game-changing discoveries.

We are in the midst of a technological revolution in computing that has been unfolding since 1950 and is having a profound impact on all areas of science and technology. As computing power doubles every eighteen months according to Moore's Law, unprecedented levels of data collection, storage, and analysis have revolutionized many areas of science.

For example, optical microscopy is undergoing a renaissance, as computers have enabled us to localize single molecules with nanometer precision and image the extraordinarily complex molecular organization inside cells. This has become possible because computers allow beams to be formed and photons to be collected over long stretches of time, perfectly preserved and processed into synthetic pictures. High-resolution movies are revealing the dynamics of macromolecular structures and molecular interactions for the first time.

In trying to understand brain function, we have until recently relied on microelectrode technology that limited us to recording from one neuron at a time. Coupled with advances in molecular labels and reporters, new 2-photon microscopes, guided by computers, will soon make it possible to image the electrical activity and chemical reactions occurring inside millions of neurons simultaneously. This will realize Charles S. Sherrington's dream of seeing brain activity as an "enchanted loom where millions of flashing shuttles weave a dissolving pattern, always a meaningful pattern though never an abiding one; a shifting harmony of subpatterns."

Computers have become the new microscopes, allowing us to see behind the curtains. By 2015, their power will begin to approach the neural computation that occurs in brains. This does not mean we will be able to understand that computation, only that we can begin to approach the complexity of a brain on its own terms. Coupled with advances in large-scale recordings from neurons, this increase in computer power should by then enable us to crack many of the brain's mysteries, such as how we learn and where memories reside—though I would not expect a computer model of human-level intelligence to emerge without other breakthroughs that cannot be predicted.

SILICON IMMORTALITY: DOWNLOADING CONSCIOUSNESS INTO COMPUTERS

DAVID EAGLEMAN

DAVID EAGLEMAN is a neuroscientist at Baylor College of Medicine and the author of *Sum: Forty Tales from the Afterlives.*

While medicine will advance in the next half century, we are not on course to achieve immortality by curing all disease. Bodies simply wear down with use. We are on course, however, to achieve technologies that let us store unthinkable amounts of data and run gargantuan simulations. Therefore, well before we understand how brains work, we will find ourselves able to digitally copy the brain's structure and download the conscious mind into a computer.

If the computational hypothesis of brain function is correct, it suggests that an exact replica of your brain will hold your memories, will think and feel the way you do, and will experience your consciousness—irrespective of whether it is built of biological cells, Tinkertoys, or zeros and ones. The important part about brains, the theory goes, is not the structure; it is the algorithms that ride on top of the structure. So if the scaffolding that supports the algorithms is replicated—even in a different medium—then the resultant mind should be identical. If this proves correct, it is almost certain that we will soon have technologies that allow us to copy and download our brains and live forever in silica. We will not have to die anymore. We will