Down the Rabbit Hole

Do any of our capabilities and experiences inform us that we are not in a computer simulation?

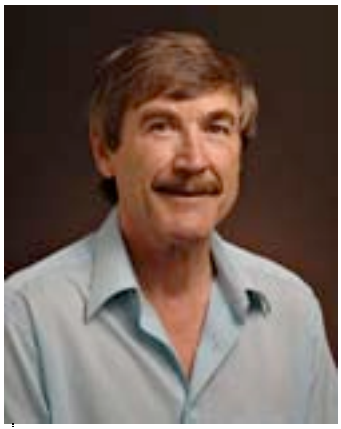
fq(x) News

by KATE BECKER

Conference Idea: Are we in a computer simulation? February 15, 2008

You are not really reading this article. This article does not exist. *You* do not exist. The computer you're reading this article on doesn't exist, either. But in one way, the computer is more real than you are: It may be the nearest we will ever come to understanding the truth of our universe.

Welcome to the simulation hypothesis. Here's the idea: An advanced civilization decides to create a detailed computer simulation of another civilization. They fill up their mock world with people, plants, and animals, and they write rules of nature governing how the fake universe evolves. Maybe they are simulating their ancient ancestors; maybe they are tweaking physics to see how it all pans out; or maybe they're just bored and looking for a little entertainment.



PAUL DAVIES
Arizona State University

To the creatures inside the simulation, though, none of that matters: the purpose of the simulation is inaccessible to them. After all, they have no idea that they are just ones and zeroes in what Paul Davies, a theoretical physicist at Arizona State University, calls a "superdupercomputer."

If you can accept that, you've taken the first step down Alice's rabbit hole. The next step in this simulation proposition is the hope that civilizations will progress far enough to amass the computing power necessary to produce self-aware societies—not just fun games of Sims—so that they won't, say, bomb themselves into oblivion, be overtaken by superviruses, or be enslaved by robots first.

The way things are heading in our neck of the woods, you might wonder: Are we living in a real universe or a fake one? If you've swallowed his argument so far, says Davies, the rest is just "a numbers game" that boils down to one question: "Do fake universes outnumber the real ones?"

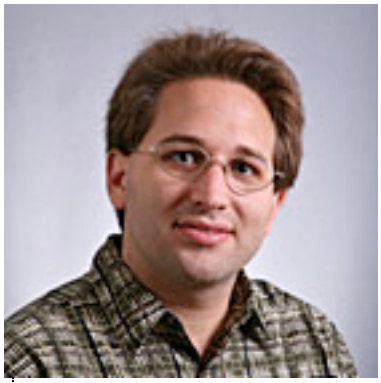
> If you make generous enough assumptions about the machine doing the simulating – and again, why the hell not – then the simulation hypothesis can never be falsified!
>
> *- Scott Aaronson*

Of Bugs and Other Glitches

The numbers are in favor of the fakes, argues Davies, for a simple reason: "A movie is much cheaper than the real thing." The fakes, that is, take fewer resources to operate than the real universes, so they should be more abundant—and more populous—than real universes. Conclusion: Odds are, we're living in a fake.

So if our universe really is just a program running on some advanced civilization's supercomputer, would we ever be able to tell?

"If the simulation is perfect, it's indistinguishable from a real universe," says Scott Aaronson, an assistant professor of electrical engineering and computer science at MIT. But, since few things in life, simulated or no, are perfect, there could be bugs—little glitches in the programming that might appear as changes in the constants of nature. As the theorist John Barrow has put it, perhaps "the flaws of Nature are as important as the laws of Nature for our understanding of true reality."



SCOTT AARONSON
MIT

Some astronomers think they have already detected a slow creep in one constant of nature called alpha, the fine structure constant. Experiments in the lab, however, have failed to back up that observation. Even if they did, could we ever know that those changes are evidence of tiny computational errors—or just the real physics of our real universe?

Max Tegmark, an associate professor of physics at MIT, thinks that tracking the fundamental constants is important work, but he doubts it will yield any insights into the simulation question. "Any entity with technology good

enough to simulate the universe would have no problem fooling us" by holding the constants perfectly still.

Crunching the Numbers

So what kind of computer could run a simulation as sophisticated – if it isn't too presumptuous to say so – as our universe? Would it be a classical computer the size of a planet? A quantum computer no bigger than an iPod? Or could it be some kind of computational device we haven't even imagined yet?

The simulation argument doesn't specify. However, theorists have established a "holographic limit" that quantifies how much information can be contained in a volume of space. Do the math, says Aaronson, and you'll find that a quantum computer with about 10^{122} quantum bits, or "qubits," should "suffice" for simulating our observable universe.

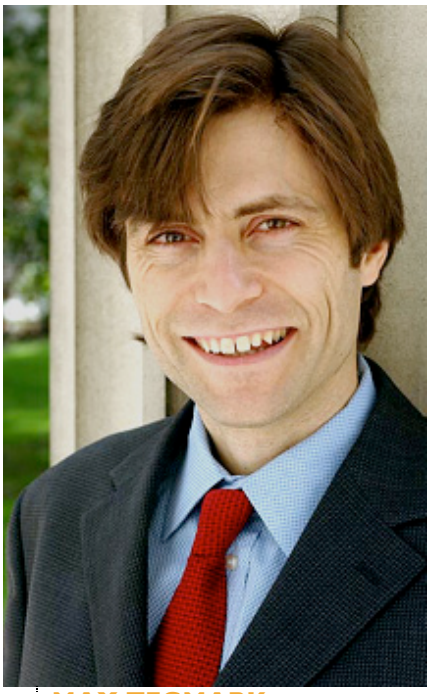
Now that's a lot of qubits: Today's most advanced quantum computers are working with just a handful, and all the classical computers on the planet put together wouldn't come anywhere close, bit-wise. Seth Lloyd, a professor of mechanical engineering and engineering systems at MIT, estimated in 2001 that all the man-made computers in the world registered about 10^{21} bits.

So the computing power needed to create our universe pixel-for-pixel seems to be very high. But, explains Aaronson, "It's possible that a much weaker computer would also suffice." Perhaps the simulation could make a few cheats to gain efficiency, filling in parts of the universe only as needed, say, by having trees falling in the forest make a sound only if someone is listening, or inscribing words in a book just before the reader turns the page.

But why speculate on such computational corner cutting, argues Aaronson, when the simulator might be able to process a "googolplex" bits every second? "That's the fundamental problem with the simulation hypothesis," says Aaronson. "If you make generous enough assumptions about the machine doing the simulating—and again, why the hell not—then it can never be falsified!"

Or Skip the Numbers Altogether

Tegmark takes what he calls an "unorthodox view" on the issue. "I feel it is incorrect to equate the one-dimensional flow of time with the one-dimensional flow of computation." The passage of time as experienced by a citizen of a simulated universe, he says, is not tied to the rate at which the computer is spooling out calculations. "Run it at twice or half the speed, and you would feel the same."



MAX TEGMARK
MIT

More importantly, argues Tegmark, why run the simulation at all? Taking Einstein's view that "change itself is an illusion," Tegmark says that the simulation could take the form of a static four-dimensional data set. "If your life is a movie, space-time is the whole DVD," says Tegmark, noting that the DVD exists whether or not it is ever played.

The hypothesis that your life plays out for the amusement of some higher being—one who might hit the "off" button if things turn boring—leads Tegmark to provide some unconventional advice: "Try to behave in interesting ways," he says.

"It's a good excuse, if you feel like going crazy one day: You might extend the longevity of the universe."

What About Consciousness?

Maybe you can imagine a computer that simulates stars and planets, plants and animals. But can a machine truly simulate the inner life that we experience as consciousness?

The physicist Roger Penrose famously argued that specific quantum mechanical structures in the brain are responsible for consciousness, and that efforts to replicate consciousness artificially are therefore hopeless.

"I don't buy it," says Tegmark.

Aaronson agrees: "The ink was barely dry" on quantum mechanics "before people were speculating on connections between quantum mechanics and consciousness," he says. Consciousness is "*the* mystery of human existence," says Aaronson. But Penrose's argument, Aaronson thinks, "boils down to a religious proposition."

Even if the brain is some sort of quantum computer, says Aaronson, "it is still governed by perfectly precise mathematical laws." In this view, there is no reason to believe a quantum computer couldn't manufacture consciousness that feels just like the real thing.

Still, if our brains are quantum computers, Tegmark notes, they would be subject to a phenomenon called decoherence, which causes quantum computers to break down on short time scales. "If your neurons have anything to do with consciousness," says Tegmark—and most people think they do—decoherence would emerge in a vanishingly small fraction of a second. "So you'd better finish your thought very fast."

Does This Story Have a Moral?

The simulation hypothesis has been around in one form or another for ages, Aaronson points out, and is perpetually being "rediscovered and expressed in contemporary language." For example, Descartes questioned the reality of the physical world outside the mind; Lewis Carroll's Tweedledum and Tweedledee tried to convince Alice she was a character in a sleeping king's dream; and in *The Matrix,* Keanu Reeves hallucinated his life, trapped in a post-apocalyptic body pod.

"There are many old essays in the philosophy literature on the disembodied brain-in-a-vat," says Tegmark. Philosophically, "We can't be really, really, sure of anything—which is sort of humbling."

But Davies believes the real value of the simulation hypothesis is that is causes us to question the logic that brought us here. "A thought experiment that goes to absurd extremes," says Davies, suggests that something must be wrong with the underlying assumptions.

So "let's pretend the world is real," says Davies. "Then get on with the job."