

THE UNIVERSAL COMPUTER

“What is the meaning of it, Watson?” said Holmes, solemnly, as he laid down the paper. ... “It must tend to some end, or else our universe is ruled by chance, which is unthinkable.”

Arthur Conan Doyle (1892)

Hang in there babies, because everything is going to be everything.

Jo Heims (1971)

The universe is made of processes, not things.

Lee Smolin (2001)

Change is all around us. It takes a very subtle mind to notice that something so ordinary and common conceals, just beneath the surface, a fundamental mystery. What is change?

Jay Kennedy (2003)

We will work with a microscopic theory that is a pre-spacetime quantum theory.... A quantum information processor which can be used as a pre-spacetime theory.

Fotini Markopoulou (2006)

Our universe *is* mathematics in a well-defined sense.

Max Tegmark (2007)

“This must be about the way it really is.”

I’m in the shower and my head’s still full of fog. It’s for no clear reason then that I take this, his first essay today at speaking, as a shot at the Spacetime continuum. He must see it as expedient for math, but definitely not expedient for figuring what’s happening. His next shot says I have it right.

“So space and time are made of distinct bits. So what?”

His manner could become annoying but I get what he is getting at. He means what is the consequence. He is hinting that the 3-D universe must be what metaphysicists call an enduring object. An enduring object is a thing that has no time. The question is: How does it then endure? Or as he might say: How does it do it?

“That is the question.”

Well, why ask me? He has an answer of his own. He says the universe is a machine that keeps on making a new space that replaces the old. It does this for a living, so to speak. What more does he want? Like Sweet Al Monte says, or Jo Heims has him say, ‘everything is going to be everything’ and it *is*, a gazillion

times a second, and it's Poe who makes this happen too, the misty movie I mean. His wife again, lost love of his life.

Sweet AI's babies don't have to hang in there very long before he's proven right. About 5×10^{44} seconds by Buddy's watch will do. But Buddy and his watch bring me back to a question that is hanging in the back of *my* mind. Of course these last words bring back Wilson and the Beach Boys. Oh to bring them all back with those hazy days! But would I then be here? Anyway, my question is, what does Sweet AI tell his babies if the Cosmic Clock decides to run at, say, half speed? What does Buddy tell Sweet AI?

I'm asking this because the answer just now came to me: Buddy's time won't change! In different guise this is the one about the stopping of the Cosmic Clock. The only way we can tell time is change—things that move in space. Like clock hands or electrons. I want to say to Frank, hang in there as this must say something about how it works. The Cosmic Clock is not just any clock. It Tocks the Moves that he has making space and making things move in it. I want to call it all the *Universal Computer*. I want to say to Moyer, watch this space. He asks, 'Is space digital?' in the title of his Sci-Am article in 2012. Does he answer? Well, not yet but Frank sure does. And his answer to Jay Kennedy's deep question must be: Change is what the *UC* causes. Change includes the movements of the hands of clocks. This gets a little tricky. Tegmark tells us, speaking of a universe that's run (or simulated) by computer: 'The rate of time flow perceived by an observer in the simulated universe is completely independent of the rate at which the computer runs the simulation.'

Like Tegmark's observer we are *in* the universe. So when Buddy checks his watch what he sees does not depend on the time it takes the Cosmic Clock to Tock.

In case this isn't clear to Sweet AI I can set him up a simple simulation. I don't need a universe. All I need is Buddy and his watch. This is easy done. I compose a short watch-watching program. It starts with a loop that takes about a microsecond. For example: Add 1 to a number, check it, and go back. Let's say this takes a thousand ticks of my computer's clock. One tick takes a nanosecond or a billionth of a second, which is lots of Tocks, but let's pretend it *is* a Tock. It makes no difference and is simpler. The computer ticks a billion Tocks, which takes a second. So it could move the second hand if Buddy has one but it's easier to do without. It starts a second second-cycle. After sixty of these cycles it moves Buddy's eye to check his watch. In Basic it looks like this:

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100 DEFINT L, M, S, T
101 CLS
102 PRINT "Buddy keeps his eye on the time."
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103 PRINT
104 C$ = ""
105 L = L + 1
106 IF L < 1000 GO TO 105
107 M = M + 1
108 L = 0
109 IF M < 1000 GO TO 105
110 S = S + 1
111 M = 0
112 IF S < 60 GO TO 105
113 T = T + 1
114 S = 0
115 PRINT "Buddy's eye looks at his watch and sees"; T; "mi-
nute"+C$+" passed."
116 C$ = "s"
117 GO TO 105

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So each time Buddy looks he sees another minute passed. Now switch to power-save. My computer's clock rate slows by half. That same step now takes two microseconds. Each Tock is thus twice as long. I know this. Buddy and his eye do not. From outside his universe I can see that it now takes two minutes to complete the sixty cycles of a million adds and loops. But Buddy checks; he sees that just *one* minute passed inside his universe. Thing is this: Buddy and his watch provide the definition of a minute in his universe. If I want to make his time go slower I must change the rules that run things *in* his universe—the program, in other words.

Set up this way it seems simple. The reason why we can assign the Tock a time is not about the Cosmic Clock. It's about the Rules the UC uses: Like, each Tock, it moves a free photon one Fleck. Time isn't about Tocks. It's about *motion*. A Tock is our term for the time we must attribute to a Move in order to make sense of motion we observe. The Cosmic Clock does not keep time; it knows nothing of it. It keeps order in the sense of sequence, Move after Move. Each Move, the UC unfolds a loss of Ordnung. It starts with perfection and reduces it to mess. It takes what we call time to do it but it only tallies Tocks.

So, Sweet Al, everything becoming everything, one Tock at, so to speak, a time, one Move following another, is the way the world endures! I'm dazzled by this universe my friend unveils. It is so beautiful in its complex simplicity that, time to time, so to speak again, I don't know where to look or what to think. He's a devious mind-surgeon and he has me thinking things I never thought.

What it comes right down to is: Wolfram's right. And so is Tegmark. The

universe *is* a computer. It's *The Matrix* minus Agents. Computers are something I grok. This one I might call the ultimate computer. But like my computer, it too is a sequencer that makes moves and they follow rules. Like my computer's, its moves have a spatial extent. And like my computer's, its moves are slaved to its clock. Each Tock, whatever happens happens all at once. But there's one big difference beyond speed and size. In mine the signals travel at the speed of light. They take time to get to each part of the system. This delay is meaningful when seen from the *outside*. In the UC there is no delay. Is he listening?

"And the reason is . . . ?"

He sounds pleased with me or—more likely—with himself.

Because there is no outside? It just jumps into my mind. It's a hit. He doesn't need to say it. I bask in self-satisfaction. Then, ten silent seconds later, come the doubts: What keeps it all together? How does it work? Behind the doubts there is another difference. My computer's complex but the parts list for the universe is short. Just how short I'm not sure but there's only one so far. If we are to know, he'll have to find what matter is. And figure how the UC keeps in contact with itself. But aside from these outstanding items, seems to me that information's all the UC has.

At any Move, its information is the way it is, it's the configuration—whatever that may mean—of all its Flecks. It keeps no record of its past. Each Move obliterates the last one. So it is the universe that sets us in the now. It's the universe itself that frames the present, moves it forward, prevents it from going back. What some call 'intuitive time'—with sometimes a deprecating slant, as though it is somehow inferior or even an illusion—turns out to tune in to the Cosmic Clock. But the only evidence accessible to physicists is movement.

Newton notes that we can't measure space:

It is indeed a matter of great difficulty to discover and effectually to distinguish the true motions of particular bodies from the apparent, because the parts of the immovable space in which these motions are performed do by no means come under the observations of our senses.

Frank would just say we can't measure Flecks. But physics is about causation, as in: This does that. Measure this and measure that and check. Anything that can't be measured gets short shrift. Now, I'm pretty sure the UC doesn't run a predetermined program. As Lemaître says, 'The whole story of the world need not have been written down in the first quantum like a song on the disc of a phonograph.' No, it must play the odds, odds arising from the shape of things, like dice or pennies. It's the croupier. It doesn't call the shots; it runs the game. Like the croupier, it can't foresee the outcome of the Flecky steps that happen at each Move. And soon each Move comprises a vast number of them.

But subject to sub-yoctoscopic randomness his universe seems kind of causal. Dimly I can see that its causality emerges. Maybe Einstein would have been a little gratified. Though I still don't know what *is* a particle, it seems a particle *may* have a path in space though never a position. Its path is not continuous since space itself is not continuous; it *is* continuous in that it never skips a Fleck.

“What does that mean?”

His question plunges me into a new uncertainty. My mental space-foam picture isn't real. Each Fleck must jiggle like a jitterbugger. The reason it's impossible to specify a path through space is it's impossible to specify the space. And yet because his space has substance it is somehow absolute.

“What does that mean?” he asks again.

He's caught me out. I'm thinking without understanding. This doesn't stop me thinking. I just park the questions I can't answer and my thoughts think on.

Absolute space made of Flecks and absolute time made of Moves are open to the same shots that were thought to have demolished Newton's. And his concepts might have stayed demolished but for two new leads: Frank has evidence that Newton didn't; and his space and time are part and parcel of a grasp of how the universe begins. They make sense of it in ways that other frameworks cannot. They may lead to new theory and new experimental tests. It's no more necessary to observe *them* than it is to see electrons. That's not how science works. Even Matthew has the measure of the scientific method: 'Every tree that bringeth not forth good fruit is hewn down, and cast into the fire.'

To escape the fire his space and time must soon bring forth good fruit. Like a time that cuts through contradictions. I can see Tock number, n_T , in equations that explain why all those old equations work so well but this needs new physics. His problem is that physicists are nervous about walking too close to the Old Divide and Huston Smith may see the UC as the mind of God, as Hawking rashly called it back before he found that God's not needed.

I take stock of these last days, the wildest of my often off-and-on wild life. I'm still straining to collect and hold his vision: Empty space, it seems, not only *not* a nothing, runs the show, its UC Moving swift beyond conceiving. At each Move it runs the Rules for every Fleck. In other words, each Move rebuilds the cosmos. Though it seems smooth to us, his universe is different from the one whose smoothness is imagined to be truthful. By my reading, Einstein's bent for smooth runs deeper than the ease of continuity in math. The intellectual gut-feel that guides him on untrodden paths recoils from the very thought of jerks. Nature makes no jumps! It is a principle to which he cleaves in line descent of thought from Aristotle via Leibniz. There is thus a special irony in finding that it makes its way to him in jerks—some 10^{54} of them.

Much of this new space is not exactly new. For example, physicists explain that, doing things like simulations of black holes, they consider Spacetime as a foliation of spacelike hypersurfaces, or slices. Each of their hypersurfaces comprises all the points in 3-D space. They are spacelike because they all exist at the same instant of time. Sliced thin enough they'd tick his Tocks.

Wearily I wonder: Could his foliation furnish physics with new math? A thought looms lonely in my mind: The UC is the ultimate observer. A feeling's seeping through some screen unseen between us: He is pleased.

As the lights go out I fumble for my keys. He has the last word.

"Poe has it right. Everything *is* connected to everything."

As I cross the street I think: What could he know of Poe? Cleaving to its Rules the cosmos jerks along its random way around me. As Dundee's Mrs. Mahon wrote back in 1898: 'The while we wait.'