On Not Simulating a Universe

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Outline: The question "What if we are just a dream or a simulation?" has a long history and it fits particularly well with the complacent nihilism of modern culture. Now that simulation-based philosophical arguments seem to be attaining respectability, it is time to examine the ontological implications of simulations.

Contemporary simulation arguments pay great attention to the computing power needed to simulate a human brain or even a universe. I argue that such considerations are irrelevant and that from the point of view of the inhabitants of a simulated universe it makes no difference whether anyone actually ever runs their simulation or indeed whether the simulation program is ever written.

If we accept that the inhabitants of a simulated universe walk, talk, eat, think, fight, and have souls just like us, we are faced with a problem because if every possible universe exists then the notion of personal identity and action becomes incoherent.

This implies that some universes (including ours) must exist while others (such as most simulations) must not; but there is no obvious candidate for this magical "existence" or "reality" that can be given to some possible worlds but not to others.

Simulation arguments raise further interesting parallels between God's creation of a real universe and our own creation of a simulated one. Comparison of the respective roles of creator/simulator and creature/simulation should lead to some fruitful and stimulating discourse between science and theology.

Keywords: simulation, creation, science fiction, ontology, computation, possible worlds.

Simulation is calculating what will happen without it actually happening. Calculating the explosion of an atom bomb is cheaper and safer than building one and blowing it up. Calculating what happens when two galaxies collide is faster than spending millions of years watching it happen.

With the rapid progress of computer technology one can imagine a time when we can simulate life – assuming, that is, that life emerges from simple physico-chemical laws without the need for some incalculable additional quality. And after life comes sentience; and then intelligence; and ultimately humanity itself. The failure of such a project would be deeply interesting, as indicating that we are made of something more than physics and chemistry;[1] its success raises questions of a more philosophical nature: do the apparently identical experiences of a

simulated being really have a different quality from ours? Do such beings have rights?

Unreal, dreamt, or simulated worlds have a long history in literature, including the Red King's dream in *Through the Looking-Glass* (is Alice in his dream or is he in Alice's?) and Cidrolin and the Duc d'Auge, the reciprocal dreamers across time in Queneau's *Les Fleurs Bleues*. The modern wave of simulation arguments is built on computers rather than dreams. The best treatments can be found in science fiction: in a Stephen Baxter short story people intentionally crash the computer that is simulating them, by exploring a larger region than it is able to simulate; in a Greg Egan novel[2] simulated beings use their own (simulated) computers to simulate another world.

For those who prefer their space operas to be labelled as non-fiction, Frank Tipler offers us quasi-omnipotent descendants in the far future who will give us a God-free resurrection by constructing a computer to simulate us and our world.[3] The resulting secondary literature is growing: if a simulation of our world is possible, indeed possible many times over, how do we know we are living in the real thing? (We probably aren't)[4]. How, if we are living in a simulation, ought we to behave? What, for that matter, is the best way to act if you want to be "resurrected" into a simulation?[5] (This is the God-free version of "What must I do to have eternal life?", though it is notable that none of these writers consider whether, or how, a simulated being might have free will). John D. Barrow, a former collaborator of Tipler,[6] urges us to look for miracles as proof of our creators' existence – or, in his more refined language, to look for "glitches" or slow changes in the laws of nature that will indicate errors or unreliabilities in the machinery that is simulating us.[7] For the refined theophobe of today, turning water into wine is vulgar but a microscopic change in the fine structure constant is both dignified and tasteful.

This paper demonstrates the construction of a simulator capable of simulating all possible universes at essentially no cost. By making these simulations cheap enough to perform now, we can remove our gaze from the godlike beings of the cosmos and concentrate on what simulation actually implies in philosophical terms.

Let us start with some postulates.

1. Life, intelligence, consciousness and soul are epiphenomena of the physical, chemical and biological processes that underlie them.
2. All of physics, chemistry and biology can be explained by a set of laws.
3. These laws are such that it is possible to simulate the evolution of a system governed by them.

These postulates have been designed to contain nothing that is repugnant to even the most theophobic of materialists.

Many people think that quantum mechanics violates postulate 3, but it does not. Although quantum processes are generally described as if they have randomness in them – a radioactive nucleus decays at a random time, the measurement of a quantity causes an unpredictable jump in the values of other quantities – it is possible to have fully deterministic models of quantum mechanics that satisfy all the laws and match all the phenomena: Bohm's "pilot wave" theory is one example. These models may be ugly but their existence shows that quantum mechanics does not necessarily contradict the determinism of postulate 3.

The calculation experiment

Now for the crucial experiment. Consider two 80-digit numbers, whose values are given in the footnote[8] and which we will refer to, for conciseness, as Bob and Carol. These numbers have been created by tossing coins. They have been chosen to be so long that the chance of their having ever been written down in the entire history of our Universe is vanishingly small.

Here, then, is a calculation which has never been done before 25 January 2004:[9]

Bob + Carol = Ted

Have things suddenly become different when this calculation was done? Have there been signs and portents? Have new stars been seen in the firmament? Of course not. The mere performing of a calculation does not change anything in this world.

What about Bob, Carol and Ted? Can we say that B+C=T became true for the first time on 25 January? Of course not. B+C=T is true always and everywhere. It would still have been true if the world had never existed at all.

So what, in the end, did happen on the cold evening of 25 January? Only this: that I discovered what the value of B+C was. The value would have been same whether I had discovered it or not. The effort I put into finding the result of B+C did not affect what the result was: it only affected whether I knew the result or not. To put it concisely:

- An isolated calculation requires no resources to perform it.

"Isolated" is the key word. A non-isolated calculation, in other words one whose result has consequences in this world (if only in the placement of ink on paper) does require resources; but even so, it always had the result that we eventually, laboriously discover – our efforts did nothing to the calculation itself, only to our relationship to it.

Simulation

The corollary is straightforward. When we run a computer program, each step is a calculation. Thus the same argument applies: the result of the 10,000,000th step of a program is the same whether or not we run the program, but in general the only way we're going to find out what that result is is to go through each of the 10,000,000 steps.

Suppose that the program is one that performs the simulation of an entire universe. It follows that:

- The isolated simulation of a universe requires no resources to perform it.

In other words: given a simulation of a whole universe, everything about it – who is born in it, who dies, who in it loves, hates, fights, argues – is independent of whether anyone ever runs the simulation. If I give you a disc with the simulation program and its data, and the entire world's computing resources are insufficient to run that program, none of this can possibly affect anything in the universe that the program simulates. Within itself, the universe has its own astronomy, geography, history, literature and even theology, and it does this whether or not we are willing to wait the millennia necessary to construct a computer that will let us observe these things.

It is sometimes objected that we can't be sure that a program has no bugs until we run it; or even that the simulated universe won't accidentally end up with no planets or even no life at all. The response is straightforward. We construct a super-simulator which sets up the initial conditions, simulates their evolution for a few billion (simulated) years, checks the result for life according to the criteria we have given it, and if it finds none, changes the rules slightly and tries again.[10]

So how far have we got?

Simulation-with-observation remains a hard problem (simulating what happens when you pour hot water on tea leaves will probably remain forever beyond our reach, along with accurate weather forecasting).

But simulation-without-observation is easy: and all the same questions about the ontological status of simulated beings arise just as much if you never interact with or observe them. In particular: are simulations just as good as reality or is there a strange metaphysical thing called "existence" that we possess but simulations do not? Remember that if our postulates are true then the invisible inhabitants of our simulations will be having exactly the same sort of arguments that we are now.

The argument from density

Theophobic thinkers tend to brush aside the question of existence by granting it to everything indiscriminately: to all possible worlds, or, in this case, to all possible simulations. This is because if some things exist and others don't then you may seek for the reason why, which is metaphysical and risks being theological. They can justify themselves by saying that theists cannot possibly object to an infinity of possible worlds if, as they claim, their God is infinite.

Maybe so. There is no obvious inconsistency in saying that everything exists. Nevertheless, the "argument from density" makes it uncomfortable to grant existence to all possibilities. Here is a very rough sketch of it.

- The [abstract] space of all possible worlds is *dense*. That is, given a possible world W that is similar to our own, we can always find another possible world W' that is even more similar.
- For any possible action that you take in this world, there is another possible world that is indistinguishable from this one in all observable details up to the moment of your action, but differs from it in that you take the opposite action.

The argument is quite detailed[11] but the outline is straightforward enough. If we grant unrestricted "existence" (whatever that may mean) to any number of possible worlds, this means that whenever you make a choice between (say) A and B, there is a possible world W_A in which "you" choose A and a possible world W_B in which "you" choose B, where up to that moment the "you"s in W_A and W_B were indistinguishable. Thus whenever you make a choice, there is a world in which you have made the opposite one, and there is no ground for saying that this world is in some sense more real or authentic than the other one.

There is no self-contradiction in this conclusion, but it goes against our experience of ourselves as beings who think and will. It may not be self-contradictory but it *feels wrong* (moreover, if you say that it feels right to you, you are thereby saying that there are infinitely many "you"s, in other worlds, to whom it doesn't feel right at all).

If we reject this "wrong" conclusion then we have to reject the previously innocuous Postulates 1 to 3. Is there, then, some magical ingredient that is missing from simulations but present in reality?

A real theophobe will get worried at this point because the only thing that is missing from simulations is Being, or Reality, or whatever you might want to call it, and once you start talking about where those things come from you'll end up talking about an ultimate Source of Being, which many call God.

The data defence

Is simulation really that easy? There appears to be one aspect of simulation that this argument has so far overlooked.

When you run a simulation you actually start with two ingredients: a *program* and some *data*. The program follows the evolution of a system according to the chosen laws of nature, while the data provide the details of the initial state. Calculation, as we have seen, is cheap as long as you don't insist on knowing the answer; but data are expensive. To create Bob and Carol meant tossing over 500 coins. To prepare a simulation of the collision of just two galaxies requires billions of numbers. Where are all these numbers to come from?

Information (or, looking at it from another direction, randomness) is the one thing that cannot grow within a simulation: each simulation has exactly as much as it started with, and no more; and it cannot give its simulated "children" more information that it possesses itself. This raises the prospect of a hierarchy of simulations and suggests some fascinating lines of research,[12] but it seems fair to say that no position in such a hierarchy is so privileged that one can call it "real" in a way that others are not. The problem of reality cannot be solved like this.

Conclusion

The proposed approach to simulation, combined with an argument from density, will make life uncomfortable for those who want to claim that universes like our own may be simulated. In fact, the awkwardness extends to universes completely unlike our own, such as Zuse's cellular automata,[13] as long as they are systems in which we want intelligent life to exist while preserving a meaningful concept of action by persons.

At the same time, it is intriguing how close the language of simulation theory has come to theology. For resurrection, there is re-simulation; for salvation, the act of ensuring that one will be simulated; for miracles, there are "glitches"; and the idea of an endless hierarchy of simulations of simulations is reminiscent of the Neoplatonists' Great Chain of Being.

On the theological side, the density arguments that have been used here may be productive of new ways of understanding creation. We are familiar with "kenosis", the divine self-limitation that is needed to make free-willed creatures possible, but a further self-limitation now seems necessary: if everything that could have been created *had* been created, our world would have been just one of an undifferentiated continuum of possibilities and personal action and identity would have been meaningless. We can see with new eyes the mediaeval manuscripts that seem to show the heavens filled with creatures waiting to see if God will choose to create them.

Martin Kochanski holds an MA in Mathematics and Philosophy from Balliol College, Oxford. He is the author of Cardbox, a flat-file database package for PCs, and Universalis, a Web-based edition of the Liturgy of the Hours. He has also done pioneering work in cryptography, and he designed the world's first commercially available public-key encryption chip.

[1] cf. Penrose's search for "the seat of the soul" after he has used Gödel's theorem to prove that we are not machines: R. Penrose, *Shadows of the Mind,* (1994).

[2] G. Egan, *Permutation City* (1994).

[3] F.W. Tipler, *The Physics of Immortality* (1995).

[4] N. Bostrom, "Are You Living in a Computer Simulation?", *Philosophical Quarterly*, Vol. 53, No. 211 (2003).

[5] R. Hanson, "How To Live in a Simulation", *Journal of Evolution and Technology*, Vol, 7 (2001).

[6] J.D. Barrow & F. Tipler, *The Anthropic Cosmological Principle* (1986).

[7] J.D. Barrow, "Living in a Simulated Universe" http://www.simulation-argument.com/barrowsim.pdf (2003).

[8]Bob = 3020788995618421547675131378692893660292557055235464439060516045798152461559661 9, Carol = 941829809431529867402728951232837586724612396749253659076490554565563434920457 00.

[9]Ted = 1243908708993372022170242089102126952753868102272800102982542159145378681076423 19.

[10] An alternative is the Borgesian approach of creating a program which simply runs all possible programs concurrently, including all conceivable simulations.

[11] For a fuller description, see M. Kochanski, "Physics and Free Will", in *The Downside Review*, vol. 111 no. 383 (1993).

[12] "Towards a Hierarchy of Simulated Universes", in preparation.

[13] K. Zuse, "Rechnender Raum", *Elektronische Datenverarbeitung*, vol. 8, pages 336-344, (1967); his subsequent book with the same title (1969) is translated as *Calculating Space*, MIT Technical Translation AZT-70-164-GEMIT (1970). See also S. Wolfram, *A New Kind of Science* (2002).