Living in a Simulated Universe

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Abstract

We explain why, if we live in a simulated reality, we might expect to see occasional glitches and small drifts in the supposed constants and laws of Nature over time.

Of late, here has been much interest in multiverses. What sorts could there be? And how might their existence help us to understand those life-supporting features of our own universe, that would otherwise appear to be just very fortuitous coincidences[1]? At root, these questions are not ultimately matters of opinion or idle speculation. The underlying Theory of Everything, if it exists, may require many properties of our Universe to have been selected at random, by symmetry breaking, from a large collection of possibilities and the Universe's vacuum state may be far from unique.

The favoured inflationary cosmological model that has been so impressively supported by the observations of the COBE and WMAP satellites contains many apparent 'coincidences' that allow the Universe to support complexity and life. If we were to consider a 'multiverse' of all possible universes then our observed universe appears special in many ways. Modern quantum physics even provides ways in which these possible universes that make up the multiverse of all possibilities can actually exist.

Once you take seriously that all possible universes can (or do) exist then a slippery slope opens up before you. It has long been recognised that technical civilisations, only a little more advanced than ourselves, will have the capability to simulate universes in which self-conscious entities can emerge and communicate with one another[2]. They would have computer power that differed from ours by a vast factor. Instead of merely simulating their weather or the formation of galaxies, like we do, they would be able to go further and watch the appearance of stars and planetary systems. Then, having coupled the rules of biochemistry into their astronomical simulations they would be able to watch the evolution of life and consciousness (all speeded up to occur on whatever timescale was convenient for them). Just as we watch the life cycles of fruit flies they would be able to follow the evolution of life, watch civilisations grow and communicate with each other, argue about whether there existed a Great Programmer in the Sky who created their Universe and who could intervene at will in defiance of the laws of Nature they habitually observed.

Once this capability to simulate universe is achieved, fake universes will proliferate and will soon greatly outnumber the real ones. Thus, Nick Bostrom[3] has argued that a thinking being here and now is more likely to be in a simulated reality than a real one.

Motivated by this alarming conclusion there have even been suggestions as how best to conduct ourselves if we have a high probability of being simulated beings in a simulated reality. Robin Hanson[4] suggests that you should act so as to increase the chances of continuing to exist in the simulation or of being resimulated in the future 'If you might be living in a simulation then all else equal you should care less about others, live more for today, make your world look more likely to become rich, expect to and try more to participate in pivotal events, be more entertaining and praiseworthy, and keep the famous people around you happier and more interested in you.' In response, Paul Davies[5] has argued that this high probability of living in a simulated reality is a *reductio ad absurdum* for the whole idea that multiverses of all possibilities exist. It would undermine our hopes of acquiring any sure knowledge about the Universe.

The multiverse scenario was suggested by some cosmologists as a way to avoid the conclusion that the Universe was specially designed for life by a Grand Designer. Others saw it as a way to avoid having to say anything more about the problem of fine tuning at all. We see that once conscious observers are allowed to intervene in the universe, rather than being merely lumped into the category of 'observers' who do nothing, that we end up with a scenario in which the gods reappear in unlimited numbers in the guise of the simulators who have power of life and death over the simulated realities that they bring into being. The simulators determine the laws, and can change the laws, that govern their worlds. They can engineer anthropic fine-tunings[6]. They can pull the plug on the simulation at any moment, intervene or distance themselves from their simulation; watch as the simulated creatures argue about whether there is a god who controls of intervenes; work miracles or impose their ethical principles upon the simulated reality. All the time they can avoid having even a twinge of conscience about hurting anyone because their toy reality isn't real, is it? They can even watch their simulated realities grow to a level of sophistication that allows them to simulate higher-order realities of their own.

Faced with these perplexities do we have any chance of winnowing fake realities from true? What we might expect to see if we made scientific observations from within a simulated reality?

Firstly, the simulators will have been tempted to avoid the complexity of using a consistent set of laws of Nature in their worlds when they can simply patch in "realistic" effects. When the Disney company makes a film that features the reflection of light from the surface of a lake, it does not use the laws of quantum electrodynamics and optics to compute the light scattering. That would require a stupendous amount of computing power and detail. Instead, the simulation of the light scattering is replaced by plausible rules of thumb that are much briefer than the real thing but give a realistic looking result -- as long as no one looks too closely. There would be an economic and practical imperative for simulated realities to stay that way if they were purely for entertainment. But such limitations to the complexity of the simulation's programming would

presumably cause occasional tell-tale problems -- and perhaps they would even be visible from within.

Even if the simulators were scrupulous about simulating the laws of Nature, there would be limits to what they could do. Assuming the simulators, or at least the early generations of them, have a very advanced knowledge of the laws of Nature, it's likely they would still have incomplete knowledge of them (some philosophers of science would argue this must always be the case). They may know a lot about the physics and programming needed to simulate a universe but there will be gaps or, worse still, errors in their knowledge of the laws of Nature. They would of course be subtle and far from obvious, otherwise our "advanced" civilisation wouldn't be advanced. These lacunae do not prevent simulations being created and running smoothly for long periods of time. But gradually the little flaws will begin to build up.

Eventually, their effects would snowball and these realities would cease to compute. The only escape is if their creators intervene to patch up the problems one by one as they arise. This is a solution that will be very familiar to the owner of any home computer who receives regular updates in order to protect it against new forms of invasion or repair gaps that its original creators had not foreseen. The creators of a simulation could offer this type of temporary protection, updating the working laws of Nature to include extra things they had learnt since the simulation was initiated.

In this kind of situation, logical contradictions will inevitably arise and the laws in the simulations will appear to break down now and again. The inhabitants of the simulation - especially the simulated scientists - will occasionally be puzzled by the experimental results they obtain. The simulated astronomers might, for instance, make observations that show that their so-called constants of Nature are very slowly changing[7].

It's likely there could even be sudden glitches in the laws that govern these simulated realities. This is because the simulators would most likely use a technique that has been found effective in all other simulations of complex systems: the use of error-correcting codes to put things back on track.

Take our genetic code, for example. If it were left to its own devices we would not last very long. Errors would accumulate and death and mutation would quickly follow. We are protected from this by the existence of a mechanism for error correction that identifies and corrects mistakes in genetic coding. Many of our complex computer systems possess the same type of internal 'spell-checker' to guard against error accumulation.

If the simulators used error-correcting computer codes to guard against the fallibility of their simulations as a whole (as well as simulating them on a smaller scale in our genetic code) then every so often a correction would take place to the state or the laws governing the simulation. Mysterious sudden changes would occur that would appear to contravene the very laws of Nature that the simulated scientists were in the habit of observing and predicting.

We might also expect that simulated realities would possess a similar level of maximum computational complexity across the board. The simulated creatures should have a similar complexity to the most complex simulated non-living structures—something that Stephen Wolfram[8] (for quite different reasons, nothing to do with simulated realities) has coined the Principle of Computational Equivalence.

So we conclude that if we live in a simulated reality we should expect occasional sudden glitches, small drifts in the supposed constants and laws of Nature over time[9], and a dawning realisation that the flaws of Nature are as important as the laws of Nature for our understanding of true reality.

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