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Article

Free Will as an Emergent Property of Intelligent Life

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Abstract: Free will is a question that has interested scientists and philosophers for centuries. It is a staple of discussion in some academic fields and is a lively topic in the popular press and social media. In the present paper, I present a simple argument for free will as an emergent property of intelligent life. In short, the consensus view in physics is that quantum mechanics is inherently probabilistic and processes such as radioactive decay are truly random. Following this, there are quantum random number generators that can be used to inform probabilistic decision making in computers, and in ourselves if we desire. A conditional decision (I will do x with 90% probability) that references a quantum number generator is not deterministic and the future that follows is therefore not determined. To put it into the context of the famous thought experiment, if one could go back in time and redo such decisions, they would not stay the same. The ability to link randomness in the quantum realm to conditional probabilistic action at the macroscopic level is argued to be one of the many cases of radical emergences that must proceed from the evolution of intelligent life with significant technological advancement.

Keywords: free will; determinism; decision making; emergence

What Is Free Will?

There are two distinct notions of free will. The first is rarely expressed simply but is often at the bottom of a great deal of tangled speculation. This is the idea of a ghost in the machine, or dualism (Descartes 1641; Libet 1999; Watson 2003; Baumeister 2008; Ekstrom 2018; Fischer et al 2024). Here, the belief is either that the mind operates fundamentally differently from the rest of matter, or that one has a soul that is distinct from physical reality. Free will then becomes the ability to do as one likes independent of the cause and effect of the physical world. This notion of free will falls outside the scope of the present work.

The second notion of free will is more testable and can be scientifically addressed to some extent. This is the idea that the universe is a clockwork of purely deterministic processes and hence the future is every bit as fixed as the past (Einstein 1950; Hawking 1993; Greene 2011; Carroll 2016). This goes back to Laplace's demon (Laplace 1814). The classic thought experiment for this, which we will return to repeatedly, is that if you could go back in time and redo some choice you would always do the exact same thing. Hence, your belief that you have agency and that your choices affect your future in such a way that you may have followed a different path through life if different opportunities had come your way is an illusion (Libet 1999; Watson 2003; Baumeister 2008; Ekstrom 2018; Fischer et al 2024).

The alternative hypothesis to the deterministic universe idea is that reality is probabilistic, or at least probabilistic within some domains and deterministic in others. In this sense, if our choices depend on the probabilistic forces within nature, then our choices do not have fixed outcomes, and the future is not set in stone (Whitehead 1929; Heisenberg 1958; Popper and Eccles 1977; Kane 1985,1996; Rescher 1996; Stapp 2007; Dehaene 2014). Neither are the opportunities that come our way predetermined, which makes our lives an unpredictable sequence of events. To flesh this idea out, the perspective is basically that a person's choices are the result of a computation by an astronomically complex machine that has a character dependent on a person's genetics, their environment during development, and the encounters they have throughout life. This intelligent

system assesses the state of the world, and its own agendas, and does what it thinks best according to myriad considerations. In some cases, this means a deterministic decision, such as every time I am under water I try to surface to breathe, while in other cases it involves a probabilistic decision either because one does not know the right thing to do, or the choice is arbitrary. In such cases, we imagine that we are doing the mental equivalent of making a conditional decision with some probability that maximizes our success. I might believe that my decision was based on a 60% certainty that my choice was right, for example, meaning that there was a 60% chance that I would have behaved the way I did. Whether the decision is conscious, or unconscious is irrelevant with respect to whether the decision is probabilistic or deterministic, incidentally, as in either case the future is indeterminate. The argument is that the properties of the nervous system allow for probabilistic decisions (Dehaene 2014).

Going forward in this paper, when I use the expression 'free will' I am referring to the idea that our decisions are probabilistic in nature and hence the future is not determined but rather emerges a complex interplay of deterministic and indeterministic processes.

What Is the Simplest Empirical Test of Free Will?

The clearest way to think about free will is to explore whether the prevailing scientific consensus in physics and biology allows probabilistic behavior. In other words, does free will break any of the known laws of physics? Second, if free will is possible, does it exist? There are two ways to explore this question, only one of which will be the subject of the current paper. The first approach is to try to decide whether we think the probabilistic nature of quantum processes could influence biological systems (Heisenberg 1958; Popper and Eccles 1977; Kane 1985,1996; Rescher 1996; Stapp 2007). This is the hard approach to the problem that I will address in a follow-up paper. The second approach is easier, and the subject of the present work. Following our first question, one approach to whether free will is consistent with the laws of physics is to question whether we can engineer it? In other words, demonstrating free will does not require proving that we have it; instead, we can focus on whether it can be artificially produced.

The Argument for Free Will as an Emergent Property of Intelligent Life

The most widely supported perspective on aspects of quantum mechanics such as nuclear decay (alpha and beta), quantum tunnelling, and field fluctuations is that they are random (Born 1926; Lamb and Retherford 1947; Casimir 1948; Dirac 1958; Bell 1964; Feynman and Hibbs 1965; Hawking 1974; Martinis et al 1987; Norman et al 1988; Steinberg et al 1993; Sakurai 1994). The easiest of these to understand is radioactive decay. Here, a radioactive atom can simply be observed, not disturbed in any way, and the rate at which decay occurs recorded. The rate is unpredictable and random as far as we can tell. Of course, there have been many attempts to find structure in what appears to be a random probability distribution (collected over many decades), but these attempts have either failed, or are too preliminary, to affect this paper which is based on the current scientific consensus only (Shnoll et al 1998; Silverman and Strange 2009; Jenkins et al 2009; Krempasky et al 2013; Norman et al 2009; Pomme et al 2017).

The reason why the random aspects of quantum mechanics have not led to universal belief in a probabilistic universe is that these effects are thought, by most physicists, to not extend into the macroscopic world (Greene 2011; Carroll 2016). This is either because determinism emerges at higher levels or organization, or because randomness is canceled out in the mass action of millions of molecular interactions. Hence, individual molecular interactions might have a random component, but their collective behavior is deterministic. This is the same argument for why individual molecular motions which are stochastic produce continuous group level outcomes in classical physics.

This brings us to the core argument of this paper. Quantum random processes have been used to produce random number generators, which are considered truly random by current physics. These are used in simulation modeling, and in encryption algorithms, for example, whenever probabilistic action is required (Stefanov et al 2000; Herrero-Collantes and Garcia-Escartin 2017). If we consider the information these observations produce from the perspective of free will, then a simple fact

emerges. Consider, for example, that I write a program to perform some task conditional on the value produced by a quantum random number generator. Given that we think these are truly random numbers, then this program would be predicted to behave differently were we to run it again in the time travel thought experiment. Moreover, a general AI algorithm connected to a quantum random number generator would be engaging in free will, that is making truly probabilistic decisions in a world in which the future cannot be predicted. This would not be because of lack of information at present but because the future is indeterminate. Finally, since we are already using quantum random number generators to influence actions at the macroscopic level, we have already introduced quantum indeterminacy into the macroscopic world. Free will is thus in the world now, whether it ever was in the past

With respect to human decision making, if we assume, for argument's sake only, that we do not have free will, and our decision making is purely determined, then we can solve this problem by using a quantum number generator to inform those decisions we wish to be probabilistic. I just, for example, decided to take a sip of my coffee because the random number I pulled from a quantum random generator was higher than a cut off I set. If I could rerun this situation (by going back in time), then I would sometimes take this sip and sometimes not. Further, this is not a random decision, but a conditional one that follows from a goal-oriented decision-making process. Finally, given that life involves millions of decisions, big and small, many that interact and amplify one another in highly nonlinear ways, my future would be impossible to predict even a short time later if I used such a method with any regularity. It is thus easy to make human decision making truly probabilistic by referencing the randomness inherent in quantum mechanics.

Conclusions

There are several conclusions we can draw from this work. First, of course, is that according to the mainstream interpretation of quantum mechanics free will is both possible and currently present in the world as an emergent property of intelligent living systems. It may also be a property of all living systems, or those with nervous systems of sufficient complexity, but I leave that question aside for future work. With respect to the notion of emergence, the capacity for emergence in living systems and particularly in intelligent living systems must be vast. A living system is one in which there is agency (goal-oriented behavior) meaning that much of the behavior of such systems must be absent from abiotic processes. Much of what an animal does is thus emergent, and inferences from physical systems are insufficient for determining the limits of biological possibilities. Moreover, intelligent living systems with sufficient technology to probe the depths of the universe can make discoveries that will allow for behavior that transcends many boundaries present in physical systems. In the present case, it is thought that quantum processes cannot affect macroscopic things for a variety of reasons, but this overlooks the fact that we can capture the information from quantum processes and use it to influence matter at our spatial scale. In general, when it comes to the study of emergence, we have never been good at predicting it from lower-level phenomena (Crutchfield 1994; Fromm 2005). We instead discover it at the scale at which it emerges and then try to make sure that it does not violate any of the physical laws we have discovered (van Delft and Kes 2010). Hence, when a person argues from knowledge in physics about what is possible in biology, it should be taken with a grain of salt.

Finally, there are a great many ideas like the Many-World's interpretation of quantum mechanics and Superdeterminism that I have avoided in this paper (Everett 1957; Dewitt 1970; Bell 1987; Greene 2011; Carroll 2016; 't Hooft 2016; Hossenfelder and Palmer 2020). Some of these could be said to invalidate my arguments. My response is that these ideas are hypotheses with no empirical support. If one wishes to believe in such things, it is their right to do so, but they should not bring them into discussions that are sold as being based on conventional wisdom. Conventional wisdom refers to scientific principles that are universally agreed upon by practitioners of the relevant subject. Conventional wisdom also, in my opinion, must depend on clear empirical support. Arguing against free will based on speculative ideas while invoking the authority of physics risks slipping into an appeal to authority.

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