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A Gambler's Guide to Free Will in a Deterministic Universe, Part I

by Brian Space
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Gamblers are familiar with randomness – our brains seem attuned to celebrate the uncertainty. Yet the laws of physics give us a deterministic universe where incomplete information leads to what is called randomness. The uncertainty is the product of our ignorance. Here I explore the consequences of this situation from gamblers point of view (**POV**) in a purely classical mechanical (**CM**) universe. The next article will explore how a quantum mechanical (**QM**) universe with true randomness changes the situation. Further, I find that these issues come up amongst savvy gamblers and the discussion often leads to the nature of consciousness and the conundrum of free will (**FW**) in a completely deterministic universe. Let's explore these ideas by starting with what humankind has figured out about the basic functioning of the universe.

Let's start with a quick dive into the laws of nature as they are currently understood. Given these, perhaps I can explain certain indispensable foundations for explaining free will and consciousness. I am not seeking to directly provide any insights into the nature of consciousness -- this is a very young area that will grow with knowledge from brain science, complexity theory and computation. Nonetheless, any theory of will or awareness has to play by the rules of the game or proposed new rules that also explain the large body of physical knowledge that is both empirically testable / tested. The current state of knowledge is ensconced in a concise predictive form via QM and its reduced form of Classical Mechanics, (CM) and General Relativity (its reduced form is classical gravitation and its associated symmetries). By reduced form I mean the e.g. QM reduces to CM when particles are not too light and then both theories give the same predictions. CM is in a sense a subset of QM. The universe appears to be essentially quantum mechanical, but complex phenomena can often be explained purely by the reduced classical mechanical theory.

The rules of nature are deterministic classically, i.e. via CM. Particles interact via known forces. Electromagnetism and gravity are the ones we see every day explicitly and the weak and strong nuclear forces govern nuclear structure that is largely invisible to us except that we can be grateful they make matter stable. These forces have explained every phenomenon that has been observed or measured to date. QM is also deterministic but in a more complicated fashion that explicitly involves randomness that I will tackle in a future article.

In CM, if the state of the universe is specified at any given time, its past and future is known exactly; Newton's equations tell us time evolution forward and backward. CM takes as input the forces and they are known to us as mentioned above. So, if it is known where everything is at a specific time and how things interact, everything is determined. Thus, these equations are called deterministic and in as much as they describe a universe it is too.

This idea predicts that the universe started as a singularity because running the CM equations backward compresses the universe toward a single space / time point. It also tells us the universe is going to expand forever and become a very lonely place in a trillion years. It allows us to imagine if there was just a little more mass the universe would stop expanding and be stable or even start shrinking again – alas it appears it will expand until time itself ceases to exist.

CM also predicts the orbit of the earth and informs our calendars in great detail. Classical mechanics has been tested in exquisite detail and has never been contradicted in its realm of validity. Note, it is not a theory for the motion of very small particles like electrons – although it accurately predicts the motions of both atoms and galaxies. CM also breaks down concerning motions that are a significant fraction of the speed of light or concerning gravitational fields or accelerations that are very strong. For example, the orbit of mercury cannot be explained by CM alone as it is close enough to the sun to experience relativistic effects. Indeed, explaining the deviations from CM was a triumph of Einstein's theory.

Nonetheless, it is conceivable that consciousness / FW are describable in a purely classical framework. What I mean is that, while our Universe is not classical and QM has some very interesting features, one might simulate a purely classical universe and have conscious beings emerge as a feature of the laws of their computed universe. This is an open question but there is no obvious reason to believe a priori it is not possible.

CM has no room for randomness taken from an omniscient point of view (POV). This is not a trivial point. Any subset of a purely classical universe will have plenty of randomness due to incomplete information. If we flip a fair coin, the results are random from our POV although it is a deterministic process. However, there is no limit with the classical mechanics framework to obtaining more information. Note, this will change profoundly with a quantum description. But in CM, additional measurements can be made to reduce the uncertainty and make the prediction of the coin flip predictable to arbitrary precision. In this framework, randomness is a product of ignorance or incomplete information. Not knowing your opponent's cards in poker makes it a game of incomplete information, as does not knowing the cards to come in a flop game. Note, in principle this information is available via investigations such as looking at the unknown cards, sharing information amongst players or marking the cards.

Even this type of classical incomplete information randomness might explain consciousness and FW. Being a part of the universe itself, we are limited in our knowledge of the conditions of the universe. One cannot even store all the information to be omniscient. This would require recording and measurement resources on the order of the universe and change the universe in the process. Thus, even in a classical mechanical universe we will always live in a state of incomplete information.

Further, the classic equations of motion are chaotic, or sensitive to the detailed initial conditions. Real life examples of this would be predicting the weather or the results of throwing the dice in craps. In weather, a small change to the pressure in a small region quickly has major effects on the weather miles away. This makes our weather predictions limited in time even though we know the time evolution equations and can solve them on a computer. In craps, you can try and throw the dice exactly the same way each time and you will still get a "random" result. Casinos need this to be true to offer the game. Thus, uncertainty is inherent in even a CM universe. These are examples of incomplete information randomness. QM offers a different form of "true" randomness in the sense that no more information is obtainable, and outcomes are purely probabilistic.

What does this have to do with FW? Consider the following thought experiment. Imagine I give you a cheating device that uses optical recognition via a neural network like Google translate trained in optical card recognition. This version of the device catches an incomplete view of the dealer in a blackjack game dealing her last card and "decides" what it was. You have the choice to double your bet and the dealer is hitting a 16 showing. The optical cheating device gives you a message as to whether it thought the card was a picture card or not. You decide ahead of time to follow its useful yet imperfect advice. Thus, you can now beat the blackjack game on average. The optical recognition is imperfect and sometimes you lose your bet because the machine "decided" incorrectly what the card to come would be. Your wins and losses still seem random, but the process itself involves no decisions.

Everything in this example can be framed as a classical mechanical simulation. Indeed, the machine optical recognition is deterministic, and it is not really "deciding" anything. A deterministic computational algorithm is simply providing less-incomplete information, i.e. more information, and our odds improve. There seems to be randomness and decisions involved but it's purely deterministic.

Now consider that the dealer is a little sloppy and you have no cheating device. You are a sharp advantage player and the dealer's card flashes so you can see a glimpse of the card to come. You cannot see it clearly but have a guess as to, e.g. whether it is a picture card or a lower rank card. Again, you can exploit this information and beat the game "deciding" to double your bet whenever it is not a picture card. This situation is logically equivalent to the one above and no choice was involved. Your brain uses some (arguably classical mechanically enabled) algorithm to guess the identity of the flashed card and you proceed with a little more information and a gambling edge. There is no essential difference between using the computational optical device or your brain to increase the information used to double the bet or not.

This is a glimpse into how incomplete information forms a basis for choice and consciousness. The brain via your eyes is following the rules of nature and is designed via evolution to gather information in the same way the optical recognition device was designed. In both cases the deterministic universe produces "randomness" and "choice" via incomplete information.

Next time, I will expand these ideas to explicitly include randomness in the discussion of "choice". QM has foundational randomness and CM has incomplete information-based randomness as a feature. Thus, QM has both kinds of randomness as CM is a subset of QM. An example of using randomness in decisions is generating a random number in game theory to randomize one's actions in mixed situations to balance equivalent expected value situations. Another is flipping a coin for stacks when one has had enough punishment from the Universe at the end of a long losing poker session. These events are distinct in whether choosing the random number is QM or CM in nature. This is a very unusual feature of our universe.

Indeed, QM has a spooky kind of randomness that might also mean there are enormous numbers of copies of us forming every second when a quantum coin is flipped. Further, an important open question is whether QM plays any important role in the computational evolution of the brain. That QM governs certain physiological processes is clear. It is known that many aspects of biochemistry cannot be explained without QM. The open question is whether QM is essential for brain function from an algorithmic / computational POV. Does our perception of the universe, FW and consciousness require randomness and / or QM? This is a great unresolved question.

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