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God Does Not Play Dice With The Universe!

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Abstract

Objectives: This review advocates absolute determinism in our universe and reinterprets Quantum mechanics while doing so. Then it discusses some of its consequences across fields. **Method:** This study starts by proposing the absolute postulate of the universe and derives absolute determinism using concepts from both the classical and quantum mechanics. Then it advocates that though the universe is deterministic, it is unpredictable. Statistical outcomes of a classical experiment and probabilistic outcomes of a quantum experiment are not due to the indeterministic nature of the experiment but due to theoretical limit of calculation/ practical limit of measurement. The study then proposes that the "free will is an illusion". As the paths of the particles are determined, the paths and interactions of neurons and neurotransmitters are determined and thus the thoughts and actions are determined. Thus, free will is an illusion. Then it focuses on some consequences like the outcome of a radioactivity experiment, resolution of Schrodinger's Cat Paradox and that of EPR Paradox. The study also touches upon chaos theory, Big Bang theory and consciousness. **Findings:** Based on Bohmian Mechanics, Superdeterminism and Cellular Automata Interpretation, this study proposes a new interpretation of quantum mechanics. Using absolute determinism, it also argues that free will is an illusion and support it with Benjamin Libet's experimental findings in neuroscience and fMRI scans done later. The study discusses deterministic but unpredictable identification of the particle that will disintegrate next among N particles collected in a block. It also attempts resolution of Schrodinger's Cat Paradox and that of EPR Paradox. Towards the end, the study explores chaos theory, Big Bang theory and consciousness. **Novelty:** In the new deterministic interpretation of QM, a distinction is made between what is real in the universe and what is measurable or calculable. For example, it reiterates that a particle's position and momentum are fixed even if they can't be measured or calculated precisely and simultaneously (a re-interpretation of HUP). In other words, the study implies that the famous quote of Albert Einstein – "God Does Not Play Dice With The Universe" holds true in the realm of quantum mechanics also as it already does in classical mechanics.

Keywords: Universe; Determinism; Heisenberg Uncertainty Principle; Quantum Mechanics; Laplace Demon; Free Will; Benjamin Libet; Consciousness; Theory of Everything

1 Introduction

Since the debates⁽¹⁾ between Einstein and Bohr with Einstein arguing that reality is independent of the observer and QM is incomplete and Bohr arguing that reality is probabilistic and QM is complete, the correct interpretation of the quantum mechanics and whether the universe is deterministic has been debated by physicists and philosophers. The fact that this problem has survived 100 years with some of the best brains having worked so hard to solve it - shows how difficult and important it is.

This study particularly studied Copenhagen^{(2), (3), (4)} Interpretation, Many Worlds^{(5), (6), (7)} Interpretation, Bohmian^{(8), (9), (10)} Mechanics, Superdeterminism^{(11), (12), (13)} and Cellular Automaton⁽¹¹⁾ Interpretation. This review discusses them in **Appendix A** with respect to the proposed interpretation. This review proposes that the world is completely deterministic by proposing the absolute postulate of the universe and uses classical mechanics (Newton's Laws and Laplace's⁽¹⁴⁾ Demon) to argue absolute determinism⁽¹⁵⁾. This study also proposes a new interpretation that asserts the distinction between determinism and unpredictability in the universe.

Though the universe can't be predicted using calculations or measurements because there are simply too many particles required to make a reliable prediction of the universe. Similarly, barring a few simple cases, outcomes of an experiment can't be accurately measured/ calculated accurately. The Heisenberg's Uncertainty Principle^{(16), (17)} (HUP) puts a theoretical limit to the simultaneous measurement/ calculation of a particle's position and momentum. Although the position and momentum of the particle under study is fixed and determined since the inception of the time.

Few consequences of absolute determinism are then explored. In particular, an age-old problem - is free will real or an illusion - is looked upon. First question that is studied is - why ask this question - is free will real or illusion - in the first place. We ask this question because we are here. Then the work argues that the universe is deterministic and it was pre-determined that we will ask this question at this point. But absence of free will doesn't remove our sense of responsibility. And now, whether we feel responsible for our actions or not, is also pre-determined.

There are several schools of thought arguing different points of view on this important question. Deterministic^{(18), (19)} people are determined that the world is deterministic with some arguing no responsibility for our actions. Libertarians^{(20), (21)} argue that we are liberated to do what we want to do with some arguing that though quantum physics suggests randomness, people don't have conscious control over these random events. The study then argues that our feeling of being free - is an illusion. That's what Illusionists believe in while Compatibilists^{(22), (23)} take a middle-path between deterministic and libertarians. They argue that if we are free to choose according to our desires, beliefs and character - with no external agency controlling us - we can and should be held responsible for actions.

Using classical physics, the review argues - as has been done many times before also - that our universe is deterministic and paths of all the particles in all space and time are fixed. As neurons, neurotransmitters and other parts of the brain are made of particles whose paths are fixed; the paths and interactions of the neurons and neurotransmitters are fixed and determined. And as thoughts and emotions are built by neurons and neurotransmitters, they are fixed and determined since the inception of the universe. And thus, we don't have free will. This can be substantiated with Libet's⁽²⁴⁾ experimental findings in neuroscience and also findings of fMRI⁽²⁵⁾ scans done after that.

The study then explores a few more consequences of absolute determinism. It also argues that though we can't predict when and which particle will disintegrate in a radioactivity experiment, it has been determined since the inception of time. The study then attempts to resolve Schroedinger's Cat Paradox^{(26), (27), (28)} - claiming Cat is in a definite alive/ dead state - even if we come to know about it only when we open the box. This study also attempts to resolve the EPR Paradox^{(29), (30), (31), (32)} by claiming the information need not travel instantaneously (or even super-luminally) because the information about the observed particle has been at the location of the second particle since the inception of the time.

The review then delves into chaos^{(33), (34), (35), (36)} theory and claims - the trajectory of a cannon ball is fixed - even if we can't calculate it precisely. Thus, if two similar cannonballs are fired in similar way, they will end at different locations because something must be different in the two cases because we can't account for everything. This study's methodology ends with a short discussion on the origin and the evolution of the universe. Various approaches^{(37), (38), (39), (40), (41), (42), (43), (44)} already exist. The review proposes that the universe started from a single particle at the inception of the time at $t=0$ (traditionally known as Big Bang). Then the universe proceeded as per laws of physics in a definite classical manner. This review ends with a novel thought that the whole universe is one connected deterministic entity in 4-Dimensions. This entity - our Universe - can be called as First Cause/ Absolute/ God/ Consciousness^{(45), (46), (47)}.

2 Review Methodology

2.1 Absolute Postulate of the Universe

If position and momentum of all the particles at all the instants is fixed, the universe is completely determined.

2.1.1. Alternate Explanation

If position and momentum of all the particles at any one instant and the laws of physics (in particular Newton's Second Law) is known, the position and momentum of any particle at any other instant in the Universe can be precisely calculated. And thus, from the above postulate 2.1, the universe is completely determined. HUP argues measuring/ calculating position and momentum of even one particle accurately and simultaneously is not possible beyond the limit. This study argues that even if measurement/ calculation is not possible, the particle has a definite position and momentum at all time.

2.1.2. Many Particles System - General Relativity and Feynman's Sum of Histories

Assuming wave particle duality and our postulate (2.1), the study understands - all the particles in the Universe are waves also. The study proposes that it is possible to get an exact representation of the Universe in $4N$ dimensions, N being the number of particles in the Universe and 4 being space- time. (Similar to the space-time description of the Many Particles^{(48), (49), (50), (51), (52)} Universe in the already proven deterministic General Relativity^{(53), (54)} - a generalized form of Newtonian Mechanics and Special Relativity). The possibility of breakdown at singularities needs to be studied further.

The unpredictability in both General Relativity and Quantum Mechanics is due to difficulties in calculations/ measurements of even a small number of particles/ complex multi-dimensional waves. This results in obvious problems in classical physics especially in statistical physics and theories like chaos theory. In QM, it results in models like Feynman's Sum over Histories^{(51), (52)} which consider waves that are manageable and result in approximations like probabilities of outcomes of an experiment rather than prediction of an exact outcome.

2.2 Absolute Determinism in the Universe from Newtonian Mechanics

From Corollary 2.1.1 If the position and momentum of all the particles of the universe are known at an instant, the past, present, and future of any particle can be determined using the laws of physics and thus the whole universe is determined.

Laplace's Demon¹⁴: $d^2r/dt^2 = F(r)$ with $r(t_0)$ as position r_0 and $(dr/dt)(t_0)$ as velocity v_0 are known for all particles. Then the past, present, and future can be precisely and accurately calculated.

As shown in point 2.1.2 above, the problem arises when the number of particles becomes too big for calculating/ measuring.

2.3 Absolute Determinism in the Universe from Quantum Physics

This review advocates that QM is just a tool for calculating/ measuring results. It is imprecise and relies on probabilities of outcomes of experiments. The reality is precise and definite. Please refer to **Appendix A** for discussion on the proposed interpretation of QM and some of the other popular Interpretations of QM.

Heisenberg^{(16), (17)} showed that the position and momentum of a particle cannot be measured accurately simultaneously. $\Delta x \Delta p \geq h/2$. This study proposes that even if position and momentum cannot be calculated/ measured precisely simultaneously, the particle has definite and real values for these two quantities in the real world.

2.4 Determinism and Free Will^{(18), (19), (20), (21), (22), (23)}

Basic concept of free will consists of two steps: (1) decision-making and (2) decision implementation. As the universe is definite - motion of all the particles from start to finish of the universe will be defined, free will cannot exist. As the motion of particles building neurons and neurotransmitters is fixed and definite, the thoughts formed because of motion of these neurons and neurotransmitters is also fixed. And, hence, the free will is an illusion.

This is consistent with Benjamin Libet's⁽²⁴⁾ experimental findings that Readiness Potentials (RP) starts building up to implement a "voluntary" action approximately 350 ms before the conscious brain becomes aware of the decision. fMRI⁽²⁵⁾ scans done after him confirm his findings. Please refer **Appendix B** for discussion on our thoughts on free will and other major schools of thought on free will.

2.5 Calculation and Prediction of Future

Even if the world is deterministic, the future (or past for that matter) cannot be predicted accurately because of the following reasons: (1) The sheer large number of particles (barring some simple cases) to be considered for making a reliable prediction is formidable; (2) Heisenberg's Uncertainty Principle prevents us from calculating/ measuring the position and momentum of the particles precisely. The study tentatively proposes (2) may be derived from the (1) above.

2.6 Determinism and Radioactivity

In the basic radioactivity formula $dN/dt = -\lambda N$, we can't predict which particle will disintegrate but can predict that half of the initial particles will disintegrate in one half-life of the element in question. The study claims that even if we can't calculate which particle will disintegrate, it is pre-determined.

2.7 Schrodinger's Cat Paradox^{(26), (27), (28)}

A cat is placed in a closed box where a poison is released upon radioactive decay of an element. According to the Copenhagen Interpretation of QM, it is assumed that the cat is in a superposition state of dead and alive till the door is opened. On opening the door, the wave function of the cat collapses and the cat is found dead or alive. The paradox is how can a macro-animal like a cat be in a superposition state. The study claims that depending on the radioactive decay of the particle and subsequent release of poison at time t_0 , the cat is in a definite state – dead or alive. We just don't know it till we open the door to the box.

2.8 EPR Paradox^{(29), (30), (31), (32)}

EPR Paradox challenges Copenhagen Interpretation of Quantum Mechanics in that the changes in quantum states can travel from one particle's location to that of the other particle instantaneously. We advocate that as the Universe is completely deterministic, changes in one particle's state need not travel instantaneously (or at super-luminal speed) because the information about the state of the first particle is already there at the location of the second particle since the inception of the Universe.

In other words, the world can be non-local without assuming "faster than light information travel". Thus, the correlations may be maximal without requiring "faster-than-light-signalling". That is, the two particles can be correlated and the measurement decision at Alice need not travel instantaneously or even super-luminally to affect Bob's experiment at a distance. The information about Alice's decision – fixed since beginning of the Universe – has been at Bob's location since inception of the Universe.

2.9 Chaos Theory^{(33), (34), (35), (36)}

Two cannon balls are thrown one by one from the same cannon – keeping everything the same. Still, they land at two slightly different places. The paper advocates that there are some changes in the universe that have taken place between the two experiments and that we have not accounted for that and that causes this change of results in these two experiments. If we knew position and momentum of all the particles in the Universe, we could have calculated precise trajectories of the two balls.

2.10 Origin and Evolution of Our Universe^{(37), (38), (39), (40), (41), (42), (43), (44)} (Starting with a single particle at Big Bang)

1. At Big Bang (defined as the First Cause), with $x=y=z=t=0$, the Universe starts with a single particle with fixed position and momentum.
2. At $t = t_0$, 1st particle disintegrates into 2 or more particles - each with fixed position and momentum.
3. These particles can collide with each other, get absorbed (end of the particle) or disintegrate (create more particle) - always with fixed starting position and momentum of each particle - and governed by Newton's 2nd Law of Motion.
4. And so on.
5. This way when paths of all the particles from inception (creation of particle) to end (absorption on collision or spontaneous decay) is charted in space-time, the Universe is fully defined. When you have drawn trajectories of all the particles in all space and time, you have the Universe.

2.11 Consciousness

When we say we are Conscious^{(45), (46), (47)}, we usually mean our body and its boundary. But when we inhale or eat, we take in particles in our so-called body, process them, assimilate them, grow/ repair tissues and eject particles when we exhale or excrete. So, there is no fixed body. And thus, there is no individual consciousness. In fact, the whole Universe is one connected deterministic entity in 4-dimensions. All the particles are connected to each other as one Absolute/ Universe/ Consciousness/ God.

3 Overview

This study starts with postulating the absolute principle of the universe - If the position and momentum of all the particles for all instants is fixed, the universe is completely defined. The paper combines Newtonian Mechanics based Laplace's Demon - if position and momentum of all the particles are known for any one instant and the universe evolves according to Laws of Physics (read Newton's Second Law of Motion), the universe is completely determined - with Heisenberg's Uncertainty Principle - the position and momentum of a particle cannot be measured/ calculated precisely simultaneously. The paper does this by asserting that though the particle's position and momentum can't be measured accurately simultaneously, they are fixed.

A new deterministic interpretation (Please see **Appendix A** for comparisons with other QM interpretations) is proposed that is compatible with the classical mechanics underlying the quantum mechanics. The study claims that the outcomes of a QM experiment are probabilistic because a limited set of particles have been considered in the QM experiment (real or thought experiment). If we would have considered all the particles (a theoretically and practically impossible task), we would have got exact results. That is, the unpredictability of outcome is due to limitations of calculation/ measurement. Reality beneath is deterministic.

This review interprets HUP^{(16), (17)} as putting a theoretical and practical limit to calculation/ measurement of a particle's position and momentum simultaneously - as has been done before also. A crude analogy is that the value of Pi can be calculated to any precision we wish but never get a complete exact value. The paper then argues that the paths of particles are deterministic in reality and thus paths/ interactions of neurons and neurotransmitters are fixed since the inception of the Universe. Thus, our thoughts and actions resulting from them are fixed. Thus, free will is an illusion. This result is substantiated this with Libet's experiments and fMRI scans done later. Please see **Appendix B** for comparison with other schools of thought of free will.

The review then studies the outcomes of a simple radioactivity experiment (formula $\rightarrow dN/dt = -\lambda N$ in which we can't predict which particle is going to disintegrate but the outcome is fixed since the inception of time. The paper then tries to resolve Schroedinger's Cat Paradox^{(26), (27), (28)} - After the decay of a poisonous radioactive particle at $t = t_0$, the cat is in a definite state - dead or alive. Just that we come to know of the result only upon opening the box. This work then argues that the EPR Paradox^{(29), (30), (31), (32)} can be resolved by claiming that the information need not travel instantaneously (or even super-luminally) because the information about the first particle is at the second particle's position since the beginning of the Universe.

Fundamentals of chaos theory^{(33), (34), (35), (36)} are then examined. The study understands that the outcome of the experiment in which two balls are ejected from the canon one after another is well defined though can't be predicted. The balls arrived at somewhat different locations because between the two tests, some things changed - no matter how subtle like rotation of Earth, wind direction etc. If everything were the same (an impossibility) we would have got the same results.

Towards the end, the Big Bang^{(37), (38), (39), (40), (41), (42), (43), (44)} is seen in the light of absolute determinism. It is claimed that the universe started with a single particle at time $t=0$ and proceeded deterministically. This discussion ends with the novel thought that the whole universe is one connected^{(45), (46), (47)}, fixed deterministic entity in 4-Dimensions (space-time). This entity can be called Universe/ Absolute/ Consciousness/God etc.

4 Conclusion

This paper starts with proposing the Absolute Postulate of the Universe. It postulates that if the positions and momentums of all the particles for all the time are fixed, the universe is completely defined. Universe is absolute and completely deterministic. The study proposes a new deterministic interpretation of QM that argues that reality (fundamentally deterministic) and unpredictability (using probabilistic outcomes) are not incompatible. Various interpretations^{(2), (3), (4), (5), (6), (7), (8), (9), (10), (11), (12), (13)} of QM in **Appendix A**.

Though GR was discussed briefly in 2.1.2, this paper mainly uses Newtonian Mechanics as base for presenting the absolute determinism and other results due to classical physics. Extending the results to Special and General Relativity^{(53), (54)} will be good. For example, it can be observed that if the positions of all the particles in the 4-D space-time fabric are known, the universe

is completely defined. If we are able to prove that HUP^{(16), (17)} is due to theoretical inability to calculate the effect on the particle in question by all the rest of the particles in the Universe, QM will reduce to an approximation of deterministic classical physics.

Another angle that may be pursued is that if Sum over Histories^{(51), (52)} Equation is extended to include all the particles in the Universe, an absolute, exact and deterministic description of the universe will be obtained. This can be done because of duality of particle and wave. Obviously then Feynman's Sum over Histories becomes an approximation of such a description of the universe. Only this approximated version can be calculated and measured.

This review then discusses various consequences of absolute determinism. In particular, it is asserted that the free will is an illusion. It is also discussed how absolute determinism affects outcome of radioactivity experiment, resolution of Schrodinger's Cat Paradox^{(26), (27), (28)} and resolution of EPR Paradox^{(29), (30), (31), (32)}. The study then discusses a result regarding chaos theory fundamentals. The paper then ends with Big Bang theory explained in the context of absolute determinism. This discussion then ends with a novel thought that the universe is one connected deterministic entity in 4-dimensions. So, the whole universe can be defined to be the Consciousness/ the First Cause/ the Absolute/ the Everything/ God and so on.

It is acknowledged that his paper lacks a rigorous mathematical structure to the ideas with iron-clad arguments and logical proofs. It is hoped that one or more readers will build up on our ideas (or prove them wrong) and advance the collective knowledge of humanity.

5 Appendix A

Discussion of Main Existing Interpretations of QM with respect to Our Interpretation

There are several interpretations of quantum mechanics - some indeterministic like Copenhagen^{(2), (3), (4)} Interpretation and some deterministic like Many Worlds^{(5), (6), (7)} Interpretation and Bohmian Mechanics^{(8), (9), (10)}.

Copenhagen Interpretation advocates the universe is fundamentally probabilistic. That is, only probabilities of outcomes of an experiment can be calculated – and that is the only “real” thing that is in the universe. This view, though very popular, could not be reconciled with Classical Physics which advocates the universe is deterministic. Schrodinger's Cat Paradox^{(26), (27), (28)} and EPR Paradox^{(29), (30), (31), (32)} could not be explained.

The Many Worlds Interpretation of Quantum Mechanics advocates universe is completely deterministic. According to this interpretation, the universe branches out in many universes for each possibility. It is felt that such a multiverse is unrealistic because of issues like how does new universe(s) “fill in” with stars and galaxies in an instant. Moreover, as many have noted - such a multiverse is unverifiable.

As per Superdeterminism^{(11), (12), (13)}, choices made by experimenters are not actually “free”. This paper claims that the determinism at particle level implies Superdeterminism as human experimenters are made of particles. So, if path of particles is pre-determined, path of neurons and neurotransmitters (made of particles) is pre-determined and thus thoughts (due to precise interaction of neurons and neurotransmitters) and thus experimenter's decision is pre-determined.

Bohmian Mechanics argues that a given particle has a definite position and trajectory - as guided by pilot wave - that may interfere with other waves (even empty waves) just like Schrodinger Equation. The randomness seen in QM is due to uncertainty in initial conditions of the particle. Bohmian Mechanics is inherently non-local - requiring faster than light travel and assumes hidden variables that can't be measured due to HUP and 3N dimensions for the wave to propagate.

While proposing a slightly new interpretation of QM, this work also argues absolute determinism along with unpredictability. This unpredictability is due to the sheer large number of particles (ideally whole universe) that need to be measured/calculated for reasonably precise calculation of an event. HUP also puts theoretical limit to precise and simultaneous calculation/measurement of particle's motion.

This study proposes Absolute Determinism in the Universe. As per classical physics, QM is just a tool to calculate probabilities of outcomes - which can't be predicted precisely because there are just too many particles to include in the calculation. If we knew position and momentum of all the particles in the Universe and all the laws of physics, we could have predicted the precise outcome of any experiment.

This argument is similar to Cellular Automaton⁽¹¹⁾ Interpretation in which Hooft argues that there is determinism underlying QM. He said probabilistic outcomes are epistemic and not ontic because of “hidden deterministic variables”. Thus, he challenges Copenhagen Interpretation which claims waves are real. He hints waves are just mathematical tools. This study developed on his ideas as described above.

6 Appendix B

Discussion of Main Existing Schools of Thought on Free Will with respect to Proposed Approach

There are several major schools of thought on free will, spanning philosophy, physics, and neuroscience. Some are discussed below:

Core belief of Determinism^{(18), (19)} is - Free will does not exist. Everything (especially human decisions) is completely determined by laws of nature and initial conditions. These ideas are supported by classical physics and ideas like Laplace's Demon⁽¹⁴⁾ and by experiments like those of Benjamin Libet⁽²⁴⁾ an fMRI⁽²⁵⁾ Scans.

Counter arguments are like those from Libertarians^{(20), (21)} that quantum mechanics provides indeterminism through randomness but many people have already argued that randomness doesn't mean control and intentional decision making.

This work further argues that determinism and predictability are two different concepts. Universe is deterministic but can't be predicted accurately enough except in some simple cases. That is, we don't have free will because universe is deterministic. Yet, our actions and decisions can't be calculated accurately enough as our brain has too many particles interacting with each other and is complex.

Compatibilists^{(22), (23)} argue that we are free if we are free to do as per our wishes and desires. This paper argues that even if nobody is "controlling" us, our wishes, desires; decisions and actions are fixed and pre-determined. That is, it was decided at the beginning of the Universe that you will be reading and pondering over this sentence.

Using Laplace's Demon, it can be argued that if position and momentum of all the particles in the universe are known at any instant, past and future can be calculated - at least theoretically. HUP argues that position and momentum of a particle can't be measured precisely and simultaneously. This study argues that particles have a definite position and momentum at any instant - though that can't be measured/ calculated as per HUP^{(16), (17)}.

Also, when number of particles become large, reliable calculation of their paths in space-time becomes difficult. Thus, reliable predictability is difficult because of HUP and the difficulty in calculation/measurement of position and momentum of a significant number of particles. Thus, though the course of the universe or outcome of a significantly large experiment can't be predicted, it is fixed. And thus, we can't have free will.

Neuroscientific experiments like those of Benjamin Libet's seminal work in which he showed Readiness Potential (RP - electrical build-up in the brain) to implement a "voluntary" decision like flexing wrists starts rising about 350 ms before the conscious brain feels an urge to do so.

Later experiments like fMRI scans also confirm that the start of the implementation of a decision precedes conscious decision making. Signifying we humans are not conscious initiators of action. Fundamentally our "free will" is an illusion.

This paper's argument covers complex thoughts and decision making also - not limited to only voluntary actions - because they are also based on the same principles. Thoughts are due to the working of the neurons and neurotransmitters inside our brain. Neurons and neurotransmitters are made of particles whose paths are determined as we saw above. So, our thoughts are determined. And thus "free will" is an illusion.

Recently, using Functional Magnetic Resonance Imaging (fMRI), researchers demonstrated predicting a person's intent to move by seeing activity patterns from frontal-parietal regions, such as the premotor cortex and posterior parietal cortex, even before that person wished for that movement, corroborating with our deterministic argument.

Furthermore, research on intentional inhibition and the ability to consciously override pre-programmed actions challenges deterministic interpretations, suggesting conscious decision making. But it can be argued that - whether "conscious" decision of inhibition to override will be taken or not by the human subject - is also pre-determined - following similar reasoning as above.

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