

On the Simulation Hypothesis and Its Implications

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How to cite this paper: Hamieh, S. (2021) On the Simulation Hypothesis and Its Implications. *Journal of Modern Physics*, **12**, 541-551.

https://doi.org/10.4236/jmp.2021.125036

Received: January 13, 2021 **Accepted:** April 6, 2021 **Published:** April 9, 2021

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Abstract

This paper reports on the potential use of video games as well as gaming engines in the domain of physics and artificial intelligence. Unreal Engine 4 (UE4) [1] is used to render the history of the universe back in time to the quantum gravity era and then standard cosmology is assumed for its evolution until the appearance of life that was a simplified model of human-like evolution is rendered. The results of the simulations have a potential implication on the origin of life and matter and favorite the simulation hypothesis of the universe.

Keywords

Simulation Hypothesis, Artificial Intelligence, Quantum Gravity, Unreal Engine 4

1. Introduction

The exponential growth of game industries makes it of potential use in the domain of sciences. For instance, although the original intended use for graphics processing units (GPUs) was to compute and display computer graphics, it is now standard to use GPUs for general purpose computing including scientific computing. In addition, with the development of platforms such as OpenCL, Direct Compute or NVIDIAs Compute Unified Device Architecture (CUDA), programmable GPUs are now common place technologies for computational mathematics and artificial intelligence (AI). This naturally leads to the concept of gamification, which is a term used to describe the use of game design elements and technologies in non-game contexts [2]. In this paper, game design elements are used in the context of physics and AI. The main reason that motivates this choice is to shed some insight into the two unsolved problems in the scientific community, namely, the theory of consciousness and the theory of quantum gravity (QG) in the hope to unify them in a single theory [3]. In fact, general relativity, like electromagnetism, is a classical field theory, so one might expect that, as with electromagnetism, the gravitational force should also have a corresponding quantum field theory. However, attempts to construct QG theory have run into difficulties. One of these difficulties is that: QG is perturbatively nonrenormalizable [4]. Furthermore, quantum gravitational effects only appear at length scales near the Planck scale, a scale only accessible with far higher energies, than those currently available in high energy particle accelerators. In another hand, the nature of consciousness, that is the mechanism by which it occurs in the brain, how it arose from matter, and its ultimate place in the universe, is unknown. Our current models of reality simply do not allow for consciousness.

In this paper, we first show how we can implement the evolution of the universe and human-like intelligence in a video game and then, based on the simulation hypothesis, we propose an approach in which we consider consciousness as absolutely fundamental to our understanding of the universe rather than being an outcome after billions of years of lifeless physical processes. The results of this simulation reveal some metaphysical, ontological, and epistemological implication pertaining life and existence.

The paper is organized as follow: in the next section, we present the results of rendering the Ekyportic model of the beginning of the universe [5]. In Section 3, we propose a simplified model for the evolution of the human-like intelligence based on the implementation of a genetic, reinforcement learning (RL) and a reasoner algorithm in different contexts. Section 4 is dedicated for the discussions about the simulation hypothesis and its physical and philosophical implications. Our conclusions are shown in Section 5.

2. Rendering a Simplified Heterotic M-Theory in UE4

The ekpyrotic scenario, which will be our model of choice for rendering the beginning of the universe, is based on simplified Heterotic M-theory with the fields whose equations of motion allow it, are set to zero [6] [7]. A numerical solution of the ekpyrotic Scenario in the moduli space approximation using vacuum solution of this theory which contains flat, parallel branes was done in [8]. The results of [8] in different scenarios of the bulk potential show no collision between the bulk brane and the visible brane in the considered cases. Therefore, in order to provoke collision and as suggested in [8] we introduced an extra kinetic energy into the initial conditions for the bulk brane.

Without going into the details about the moduli space approximation (see [8] for further details), we solved the equations of motion derived from the Lagrangian given in Equation (8) of [8], numerically from t = 0 to $t = 3000/M_5$ with the parameters defined in [8] have the following values $R = 1/M_5$, $\alpha = 100M_5$, $\beta = M_5$. The initial conditions are A(0) = B(0) = 1, C(0) = 200 and A'(0) = B(0) = C(0) = 0 and we used the parabolic bulk brane potential $V(Y) = M_5 Y(Y-r)$. To provoke collision, we have set the derivative of the bulk brane coordinate, to Y(0)/R = 0.0001. The results of the simulation are shown in **Figure 1** where the collision between bulk brane and the universe happens at $t/M_5 \sim 1785$. To model the Bulk brane dynamics in UE4, we used a polynomial fitting of Y(t)/R. The result of the rendering in UE4 is shown on **Figure 2** and the real time animation can be found in a simple video game which is a virtual world with one story that was constructed for this purpose [9]. Universe evolution using standard cosmology will be shown in a future investigation. This type of simulation in cosmology has already been made, e.g., in [10], "Astera", a cosmological visualization tool that renders large scale structure of the cosmic web in real time using UE4 is presented.

AI and UE4

The history of the universe can be thought of as a sequence of information processing revolutions, each of which builds on the technology of the previous ones from the big bang to human consciousness [11]. Therefore, in this section, we propose a simplified model of human-like evolution based on the following assumptions:

1) Evolution of cells and perceptions are due to a simple genetic algorithm.

2) Evolution of brain is due to RL algorithm and a reasoner algorithm.



Figure 1. Collision of the bulk brane with the visible universe.



Figure 2. Rendering branes collision in UE4.

The genetic algorithm uses one chromosome and 5 genes and it is used only to gives the bots access to AI perception like sight, hearing and others functionalities. The RL algorithm is used to produce some axiom/rules from learning episodes according to only five states See Enemy, HearEnemy, TakingDamage, DealingDamage, and CriticalHealth and its 3 actions are Explore, Attack, and Flee. We did not include emotion and other states of mind in the learning episodes. The bots, uses only propositional logic for reasoning based on forward chaining inference with very simple knowledge base, namely, 5 possible facts and 3 propositions for inference. Meta-knowledge is not implemented in this simulation although this can be done in UE4 by introducing new concepts from previous one with the help of learning algorithm and a reasoner. We used UE4 in this simulation because it contains many useful tools for Machine Learning simulation. These tools include Blueprint Visual Scripting that can be converted into C++ code, simple-to-use Behavior Trees (BT) for setting up traditional AI, and more complex tools such as AIComponents and the Environment Query System (EQS) for giving an agent the ability to perceive its environment. We have implemented the genetic algorithm, the reasoner and the RL in a video game [9]. In this paper, and without loss of generality, the implementation of the RL is only shown.

We constructed a simulation environment for solo Deathmatch gameplay between a Behavior Tree Non player character (NPC) and an RL NPC. The Q-learning algorithm [12] updates what the expected reward value for each state-action. The algorithm has a function that calculates the quality of a state-action combination: Q: $S \times A \rightarrow \mathbb{R}$ which is as follow:

$$Q^{\text{new}}(s_t, a_t) \leftarrow Q(s_t, a_t) + \underset{\text{learning rate}}{\underline{\alpha}} \cdot \left(\underbrace{r_t}_{\text{reward}} + \underbrace{\gamma}_{\text{discount factor}} \cdot \underbrace{\max_{a} Q(s_{t+1}, a)}_{\text{estimate of optimal future value}} - \underbrace{Q(s_t, a_t)}_{\text{old value}} \right)$$

where $Q(s_p, a_l)$ is the expected reward value for the current state-action, (st, at,) of the RL NPC at time t and r_{i} is the rewards, α is the learning rate and γ is reward

the discount factor.

Many simulations were made to assess the RL NPC ability to learn to defeat the BT NPC. This was accomplished by setting the learning rate a = 0.4 and the discount factor $\gamma = 0.8$ and by rewarding the RL NPC 1 point for killing the BT NPC and 0.1 point for damaging the BT NPC. The RL NPC was given a punishment of -1 for dying from the BT NPC and a punishment of -0.1 for being damaged by the BT NPC. A screenshot of the implementation is shown in **Figure 3**. We could not find a variant of the RL NPC that could defeat the BT NPC, the best variant of the RL NPC has 63\% of the performance of the BT NPC. This is good results given that the learning episodes were very short-reaching and the state-action space was very small. Of course, this is a too simplistic approach for human evolution and human intelligence that does not include features in human behavior like planning, attentions, system behavior etc.



Figure 3. Simulation environment for RL versus AI.

Note that, this type of simulations can be used in a different context, e.g., to simulate the response of the human body immune system under viral, bacterial, fungi and other type of inflammations where communications between cells is mediated by cytokines and chemokines.

3. The Simulation Hypothesis and Its Implications

There is a long philosophical and scientific history to the underlying thesis that reality is an illusion. Perhaps, this idea was most popularized in science fiction probably in the Matrix, released in 1999. In physics, the view of the universe and its workings as the ebb and flow of information was first observed by Wheeler [13]. This shift of paradigm from understanding the universe as energy transformation to the information processing universe leads to the emergence of a new branch of science called quantum computation. Quantum evolution of a system is represented in quantum computation by a quantum circuit built from quantum gates. Consequently, two views of the world emerged, the first one, proposes that the universe is a quantum computer [11] and the other one proposes that the system performing the simulation is distinct from its simulation (the universe) [14] [15]. In this paper, we suggest another possibility which is a "hybrid" between the two propositions based on the following assumptions

1) The system performing the simulation is distinct from its simulation.

2) The rendering algorithm is based on quantum mechanical laws.

3) The universe is rendered on a pixelated screen for each observer.

4) The simulator has limited resources and always maintains a consistent world.

One may object our assumptions about the universe by claiming that classical digital devices are not very efficient to reproduce quantum dynamics. However, this is not completely true, because the computational complexity of the system could be reduced drastically if the system renders the content only when observed by an observer and if the universal wave function is known from path integral or from Schrodinger equation of quantum fields.

Under the assumption of finite computational resources, the simulation of the universe would be performed by dividing the continuum spacetime into a discrete set of points. Several observational consequences of a grid-like space-time have been proposed by Lattice QCD simulations, among them is the anisotropy in the distribution of ultra-high-energy cosmic rays, that, if observed, would be consistent with the simulation hypothesis [16].

Many physical aspects can support the simulation hypothesis, e.g.,

- No absolute frame of reference in relativity theory.
- The measurement problem in quantum mechanics depends on observer.
- Problem of time in quantum gravity which is an extrinsic parameter and need suitable observable of the clock from outside the visible universe [17].
- The Bekenstein bound [18], which relate the curvature of the spacetime with information.
- The Holographic principle, the AdS/CFT correspondence, which relate quantum gravity and quantum information [19].
- Objective reality doesn't exist in quantum mechanics as can be seen, e.g., in the delayed choice experiment.

Many physical results can be derived from the above description of the world, e.g.

- The time dilation in special relativity can be viewed as framerate adaptation of a moving object who need more resources for rendering.
- Gravitational lensing can be interpreted as a bounded massive object need more local resources to be rendered which in turn need a compromise between the polygon counts and the model fidelity and that can be achieved by changing the structure of the spacetime around the object (less polygons).
- Extradimension and compactification are similar to a projection from 3d object to 2d screen with wireframe rendering.
- Black hole Information paradox can be understood as a memory saturation and black hole radiations as freeing that memory.
- Quantum measurement can be seen as an intelligent agent in a specific state receive and process information and then make an action from a set of possible actions which forces the system to be projected into a specific state (process similar to [20]).

Time travel paradox, antimatter, and others physical phenomenon can have their interpretation within the simulation hypothesis.

In what follows, we describe our view of the universe evolution within the simulation hypothesis framework and assuming "cosmological consciousness" [21]. Meanwhile, a very promising mechanism to generate consciousness from within the universe is proposed by R. Penrose and S. Hameroff [3], the so-called "Orchestrated objective reduction", in which consciousness can originate at the quantum level inside neurons, rather than the conventional view of neuroscience that it is a product of connections between neurons.

From the above assumptions, and inspired by the many world interpretation of quantum mechanics [20] and the subjective idealism view of reality, we hypothesize the evolution of the universe in the following fashion: a cosmological consciousness being equipped with thinking tools that include inductive, deductive, and abductive reasoning, etc., and other types of thinking [22] created/simulated the universe [8] [23] [24] and start injecting random qubits, "quantum fluctua-

tion" [25], into the baby universe where information gets processed. And by observing/measuring the results a new quantum circuits can be exited and the cycle repeat through a feedback loop in a process similar to the working of the brain where the born rule can be compared to the weights in the neural network. As the system evolves subsystems emerge each of which has its own computation abilities and functionalities. This construction is reminiscent to so called the Game of Life (GOL) which is a cellular automaton invented by Conway [26]. Although, the fundamental "physics" of this world is so simple, as the game evolve, and at different scales, new "physics", "chemistry" and "biology" emerges. In fact, by choosing an appropriate initial configuration of the game, complex system emerges and Self-replication object can appear, even more surprising, emerging laws could entail new concepts and entities which do not "apparently" exist in the original laws [27]. In a more abstract way, we can think about this construction of the universe as each cognitive subsystem is equipped with a formal language that "lives" in a metalanguage [28] and having finite set of axioms (obviously not complete [29]) that define its dynamics according to some interpretation (model dependent reality) and evolves into different forms. Furthermore, we think that, this world is decomposed into three types of entities, the inorganic matter which is small structure uses simple quantum logic gates that determine its evolution, the organic matter which acquire more computational abilities for learning and human that has ability for reasoning. Space and time and physical laws can be thought of, in a Kantian language [30], as a type of relations in a mathematical structure and matter is a realization/support of this "philosophical matter" [31]. Evolution in this structure can be imagined as a process of mind from state to another state which can be translated in the material world into a Turing machines (TM) where logical statements about proofs are translated into actions of machines. Note that, even though TM are built from a simple logic gates they are able to simulate a very sophisticated video game like World of Warcraft and Fortnite. The difference between modern computers that are built upon the Von Neumann architecture of TM and the universal computation is that TM uses deterministic computation, however, universal computation uses quantum computation to explore the whole spectrum of computation which gives the system the ability to evolve by learning and making decisions. This imagination about the universe formation is similar to Von Neumann method of creating natural numbers out of empty sets who imagined that all numbers could be bootstrapped out of the empty set by the operations of the mind. In a platonic sense, that is in the world of ideas, each partition of the world would evolve by increasing its content toward the infinity or decreasing toward the emptiness or it can be locked in a minima. Therefore, attention, play a major role in this approach which depends on the system "personalities" [32]. Furthermore, we speculate that, the driving force for a subsystem to grow, that is to increase its knowledge base, is the "force of love" [33] which, in a systemic view [34] translate into creativity and novelty (this aspect is included in the video game [9]). This construction can be compared to computational ontology, used in semantic web, which defines a set of representational primitives with which to model a domain of knowledge or discourse. The representational primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members). Computational ontology uses description logic for reasoning and it is used to model genetic ontology, emotion ontology *etc* using language like Web Ontology Language (OWL) [35].

This view of the universe can be supported by the cutting-edge modern medicine where mind meets body, where mind meets DNA, where we can control our genes from the inside out. This development of modern medicine very much parallels to the science of meditation. In fact, at the heart of our physiology, from the surface level of organs systems to tissues cells to proteins is one molecule, the DNA molecule, which contains all of the intelligence which governs our whole physiology throughout our whole lifespan and also governs much of our behavior and even personality, and the DNA is governed by the laws of chemistry, the laws of physics, and then ultimately, at the most subtle level, the least excited state of physiology, is the unified field of all the laws of nature. Modern medicine has been progressively going through this pathway from the surface to the subtle, for the past several decades, surgery works on the more physical level the mechanical level, pharmacologic medicine works on the cellular level receptors molecules by changing those cellular components, molecular medicine works at an even deeper level attempting to manipulate on the protein level, modern genomic medicine attempts to understand the code contained within the DNA, the information that governs our life and lifespan and attempts to engineer on that level to change one's DNA to reverse disease and promote ideal health, and quantum medicine works on the most fundamental levels of the quantum mechanical laws of nature.

However, according to time magazine [36] our DNA is not our destiny but new scientific discoveries shows that our choices in lifestyle behavior what we think how we use and develop our consciousness can change our genes through epigenetic mechanisms.

In this description of reality, the view of the human body as a machine and of the mind as a separate entity is replaced by one that sees not only the brain, but also the immune system, the bodily organs, each cell, and even inorganic matter as a living, cognitive system with different degree of cognition. This view of reality can have implication on the major problems of our time: energy, environment, climate change, food security, financial security, *etc*, which state that these problems cannot be understood in isolation, they are all interconnected and interdependent [34] [37].

This type of thinking about the universe, the system thinking [34], can be supported by another argument that comes from the so called the Cosmological natural selection proposed by Smolin [38]. The hypothesis suggests that a process analogous to biological natural selection applies at the grandest of scales.

Finally, as an example of the feedback loop system that relate the central nervous system, "consciousness", with the material world, we consider the re-

nin-angiotensin-aldosterone system in human body, which is a hormone system that regulates blood pressure and fluid and electrolyte balance and which is regulated by a nucleus inside the brain called hypothalamus. From this perspective, we speculate that the brain controls the genetic code and even more can rewrite the genetic code in the same way we speculate that cosmological consciousness can reshape our universe!

We conclude our discussion with following phrase/prediction: "you are what you think", which is in the same spirit of René Descartes famous phrase "I think therefore I am" and it can be expressed by the following quote borrowed from [39].

In the end, I ve come to believe in something I call "The Physics of the Quest." A force in nature governed by laws as real as the laws of gravity. The rule of Quest Physics goes something like this. If you're brave enough to leave behind everything familiar and comforting, which can be anything from your house to bitter, old resentments, and set out on a truth-seeking journey, either externally or internally, and if you are truly willing to regard everything that happens to you on that journey as a clue and if you accept everyone you meet along the way as a teacher and if you are prepared, most of all, to face and forgive some very difficult realities about yourself, then the truth will not be withheld from you.

4. Conclusion

In summary, utilizing video game technologies can be a game changer in our perception of the world. We have shown the importance of these technologies in the domain of physics and artificial intelligence. We have discussed the simulation hypothesis and proposed a model for the universe evolution. Obviously, we don't claim, up to our knowledge, that the physical universe is a simulation rather we claim that the simulation hypothesis can be very powerful tool in our understanding of the material world. At the end, we think the simulation hypothesis needs more considerations from the scientific community and all found predictions/speculations need to be tested/formulated in a formal language.

Acknowledgements

This work was performed as part of the research program of Doctorate School of Science and Technology.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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