

Memory as a bridge between Mind and Universe
Nature copying a constructor algorithm of the Universe for Intelligent minds

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A constructor algorithm is presented that, after an initial bootstrap instantiation, may describe many aspects of our Universe. Memory is a foundational aspect of this short algorithm and is considered as a bridge between the physical Universe and intelligent minds. Nature is speculated to have copied the constructor algorithm for the benefit of intelligence in complex minds. The reoccurring presence of the Fibonacci Sequence and π are shown as derivative of the constructor algorithm. Human intelligence is described as arising from changes in working memory in the mind via cyclical serotonin levels in the brain.

*"All that we see or seem
Is but a dream within a dream."
-- Edgar Allan Poe*

*"Time is but memory in the making"
-- Vladimir Nabokov*

*"The concept of the computing universe is still just a hypothesis; nothing has been proved. However, I am confident that this idea can help unveil the secrets of nature."
-- Konrad Zuse, Rechnender Raum (Calculating Space)*

*"So how can a brain perform difficult tasks in one hundred steps that the largest parallel computer imaginable can't solve in a million or a billion steps? The answer is that the brain doesn't "compute" the answers to problems; it retrieves the answers from memory. ...The entire cortex is a memory system. It isn't a computer at all."
-- Jeff Hawkins, On Intelligence*

*"Serotonin or 5-hydroxytryptamine (5-HT) is a monoamine neurotransmitter. Its biological function is complex and multifaceted, modulating mood, cognition, reward, learning, memory, and numerous physiological processes."
-- Wikipedia*

*"Other, less abstract approaches to improving creativity center around the importance of serotonin. According to research... serotonin levels are tied to creativity... a gene pertaining to serotonin, known as TPH1, is associated with "figural" creativity — or creativity regarding shapes, diagrams, and drawings."
-- Jandy Le and Michael Xiong, The Scientific Origin of Creativity*

*"... bipolar disorder...the periods psychiatrists call hypomania – mild but not full-blown mania – can also involve heightened creative thinking and expansiveness, high mental speed, cognitive flexibility, and ability to make original connections between otherwise disparate ideas, all elements underlying creativity."
-- Kay Redfield Jamison, Touched with Fire: Manic-depressive Illness and the Artistic Temperament.*

*"It is a great ball resting on the flat back of the world turtle." "Ah yes, but what does the world turtle stand on?" "On the back of a still larger turtle." "Yes, but what does he stand on?" "A very perceptive question. But it's no use, mister; it's turtles all the way down."
-- Carl Sagan, Gott and the Turtles*

On the shoulders of giants, many a great mind has sought a Grand Unified Theory to explain our reality. Similar minds have also suspected that our Universe or reality had origins from a simple start e.g., a Big Bang or cellular automata rule set (Figure 1 and Figure 2). So perhaps there is a simple equation or algorithm that can explain features that we find in our reality. This work presents a model using very simple pseudo-code, and an initial intelligence (required to bootstrap initiate the repeating code), as another template in this same theoretical direction.

Academic and scientific culture derides any mention of a primordial consciousness, mind, or God-like intelligence but, although tremendous progress has been made in terms of unifying forces in our Universe, the goal of a simple and primordial equation or theory has remained elusive, as has an explanation for human consciousness.

This model imagines an initial intelligence that may inherently exist “a priori” or before the very creation of our Universe - akin to a mind in a Platonic dualist world. This intelligence could be ever-present but is required, at the very least, to bootstrap our algorithm “out of nothing” to begin the creation of our Universe, akin to the starting point of Set Theory. Echoing writings of Descartes, we can imagine a primordial awareness or intelligence that can identify and distinguish itself (SELF) from that-which-is-not-itself (NOT-SELF). This “primordial cut” is considered an instantiation act and would minimally require - simultaneously or beforehand - at least two “units of memory” - that may or may not be internal to our physical Universe. From this starting point, our simple algorithm can be used to explain a vast set of features present in our reality after this origin act.

Consider a simple constructor algorithm. The term *constructor* borrowed from the JAVA “object oriented” programming language subroutine and from the name of theoretical work by Oxford quantum physicist David Deutsch. In the Biblical book of Genesis 1:3 we have the famous existential line of “Let there be light.” But note that various elements are involved in this statement. There is the mind of a God, which is aware and makes a decision to “cut” reality into two segments, one with light and one without light (darkness) in a workspace (mind or otherwise).

We face an obvious challenge to attempt to describe origins from a realm that might be timeless or without any entities or consciousness or perhaps filled with both. But, if we assume that logic holds, even during our bootstrap start, then perhaps, following the beliefs of so many cultures in history and around the world, we must start with an initial awareness or intelligence. Consider the existence of a primordial mind with memory, awareness of a self, and a primordial “cut” decision, or segmenting of self from non-self, with these two concepts inherently stored in a primordial memory of two units. These memory units may be all that is needed as a primordial workspace. Perhaps these are the very first units of a fundamental “unit” of spacetime in our Universe. One can imagine this since, as our algorithm continues to repeat, it basically resembles a Fibonacci Sequence and, thus, increases at a rate that approaches an exponential growth rate (Figure 3). But as our reality becomes vast, we can see the growth rate of memory units increasing even more. This is of interest as it mirrors observations in our Universe that show our Universe growing at similar incredible expansion rates attributed to Dark Energy.

To summarize, our proposed algorithm starts with a primordial awareness, cuts into self and non-self (vis a vis binary 0 and 1 or “something and nothing”) with the change in these relationships being equivalent to time i.e., progressing via each cut, and then the algorithm repeats - with our entire Universe of spacetime being inclusive to this primordial realm of non-self. Two units of memory are added (pseudo-code is used ease of discussion) and a one-dimensional point in the “non-self” portion of reality is “cut” creating point 1 and point 2, point 1 and 2 define Line1, and then Line 1 is cut to create Line 1 and Line 2. Line 1 and Line 2 are used to define a two-dimensional circle and non-circle entities. This “add memory, cut, and repeat” process continues ad infinitum.

Here we need to clarify the use of the word *cut*. The term perhaps is closer to the idea of a schism. The cut can be a mental or logical identification or segmentation e.g., one line into two lines or even the breakdown of molecule into its component elements then protons, neutrons, and quarks, electrons, photons etc. But the algorithm remains the same, even in a much later complex Universe, as every simple decision (go left or go right?), click of clock, or even as entropy itself where particles decay into foundational particles and quarks as if attempting to return to the foundational origins of structure versus randomness. The primordial cut being synonymous with “something from nothing” or structure versus randomness akin to the Chinese origin philosophy of Yin and Yang.

After our two-dimensional reality is instantiated, the *cut* function thus leads to an aggregation function i.e., *not-cut* or “combine.” This is the basis for *memory* and an ideation hierarchy e.g., lines become

letters, words, sentences, paragraphs, pages, chapters, books, and libraries. All subsequent opposing “strategies,” thus, mirror CUT vs NOT-CUT including hatred vs desire, attachment vs aversion, decay vs survive. A reality, after the primordial instantiating “cut,” now exists where, even if only in two physical dimensions along with time, we can repeat the same algorithm to produce a third dimension (if even needed) and a reality of immense complexity. University of California Irvine cognitive psychologist Donald Hoffman argues that the third dimension does not exist and is used only as informational redundancy to improve fidelity of two-dimensional data:

This is exactly what Bekenstein and Hawking discovered about spacetime. It is redundant. Two dimensions contain all the information in any 3D space [1].

Hoffman’s theory is also possible in the framework of this model. This model does not necessarily require a third dimension to achieve its success in creating so much of what we observe in our reality.

Note the appeal of an origin constructor algorithm is that it may be able to eliminate vastly dualist cosmological models that involve Laws of Physics that exist “a priori” or before the creation of our reality in a Platonic Universe of perfect circles, infinity, and ideas. Consider comments from philosopher Angus Menuge: “If I am going to have an account that fully explains what’s going on when a scientist measures a system in quantum physics and deals with entanglement and all these other things, what if it turns out that that account must appeal to consciousness? Does consciousness then become part of physics? If it does, then — in a way — the debate between physicalists and dualists dissipates because the physical has just absorbed consciousness. But the dualists would have won in the sense that consciousness doesn’t reduce to any of these other things. That is what they’ve been claiming for a few centuries...[2].”

Perhaps the ongoing challenges with unifying Gravity with the other fundamental forces or the Standard Model are because Gravity is a result of foundational *cut* events (minimization of surface areas) versus the existence of graviton force-carrying particles like those of the other fundamental forces in Nature.

Note too how Quantum Mechanics, at a fundamental level, shows that our Universe is “cut” into identical minimal entities (photons, electrons, quarks, etc....) and that when one attempts to determine an attribute of one of these entities with an increasing level of detail, the detail of the corresponding attribute is decreased (position vs momentum as the classic example of the Heisenberg Uncertainty Principle). This behavior echoes a reality that “prefers” cuts and segments i.e., one or the other, but not both! Note, too, the lack of an observed decay of a proton or quark or electron. Our simple constructor algorithm: 1) bootstrap initial intelligence, 2) add two units of memory, 3) cut, and 4) repeat (Figure 4), produces results that we see in our reality and becomes almost synonymous to entropy i.e., driving (cutting) entities toward disorder.

The Principle of Least Action, so fundamental to our reality, becomes a logical outcome of this constructor algorithm. The appearance of π , present in so many aspects of our Universe, becomes a necessary result of our model as does the existence of so many shapes that resemble fundamental circles or spheres (Figure 5).

With the assumption of an initial or foundational intelligence, perhaps Nature, which attempts to use all tools at her disposal to survive, has simply appropriated the *boot code* of the Universe and, with the complexity of evolved biological brains, is then able to reuse that code in minds, thus leading to consciousness? Nature wants fecundity and variety, and it wants these ultimately to ensure survival. Nature, thus, uses all tools at its disposal; consider how plant life uses aspects of Quantum Mechanics to optimize photosynthesis i.e., Quantum Biology. Thus, it is not a stretch to consider Nature appropriating boot code from an underlying reality. This could explain the existence of consciousness in human minds as Nature using the “bootstrap code” of the Universe for its own benefits to help ensure survival.

Note how in this model numbers exist or originate as “labels of minimum memory size.” So now let us consider the origin of π . Upon the creation of a circle, following the cut of Line 1 into “Line 1 and Line 2,” we have an actual *boundary* between Circle and Non-Circle; the circumference of the circle (Figure 6). If we attempt to measure or calculate the length of the circumference of this unit circle (diameter of length 1) we begin to require a vast amount of memory units. Here, many assumptions are made but they lead to some interesting conclusions. In our model the length or digits of π do not exist “a priori” or in a Platonic realm of infinity but, rather, must be calculated using memory. But π is a very special number, and a special irrational number, indeed. As defined in Wikipedia:

Being an irrational number, π cannot be expressed exactly as a fraction (equivalently, its decimal representation never ends and never settles into a permanent repeating pattern). Still, fractions such as $22/7$ and other rational numbers are commonly used to approximate π . The digits appear to be randomly distributed; however, to date, no proof of this has been discovered [3].

Since π lies on the border between circle and non-circle it, literally, is the maximum amount of randomness and the minimum amount of structure possible, thus its presence in so many areas of reality. But in our model, to ensure a string has non-repeating and perfectly random digit placements, implies a need to not only have a memory unit for a given digit (a la an instantiation cut) but also a memory unit(s) for all of the possible permutations of every digit and digit string up to and then including the digit in question as well as the implied memory to compare them to ensure no pattern or eternal repetition exists. This idea is speculative, and resides in the field of metaphysics, but it still is simpler than a required Platonic Universe with "a priori" infinitely long numbers. In this model, the memory is added as digits in π are measured. Does this mean that measuring the digits in π could be increasing the size of the Universe a la Dark Energy expansion - perhaps?

With the above model in mind, let us now compose an updated "short history" of man's attempts to understand reality:

- Plato - reality must be dualist - a world of ideas and a physical world of material (cave shadows).
- Democritus – reductionist approach; Universe built from identical fundamental tiny atoms.
- Rene' Descartes - I and NOT-I is the starting point of understanding reality.
- Isaac Newton - mathematical rules underly reality; predictive time functions (calculus) and "law" of gravitation pattern; spacetime as Absolute.
- Gottfried Leibniz - reality from 0 and 1 - starts at two dimensions with the rest functions of relations (distances) between objects including time as the change of these. Calculus and spacetime as Relational.
- Charles Darwin - Nature appears formulaic, evolution via fitness = optimization algorithm.
- Albert Einstein - reality is a function, with space and time as a single operation! Gravity is derivative of this. Speed of light has max velocity but zero memory. No relative velocity = max memory = slowest clock time. General Relativity directly implies expanding universe and origin from single start Big Bang vs Cosmology.
- Kurt Gödel – there can never exist a finite complete system without a higher order awareness!
- John Von Neumann - set theory is only way to create math - requires a bootstrap into null set. Designs computer architecture based on memory!
- Alan Turing - code for an operating system and for program or data are both able to be encoded into the same string of code! All we need is a single "Universal Turing Machine" to "read" (cut into memory) infinite tape of binary symbols.
- Richard Feynman and John Wheeler – pursued the "why of quanta" (identical, long lasting, fundamental particles). IT from BIT. Reality is derivative and consistent with rules fundamental - delayed choice quantum eraser. "Sum of all histories" implies memory (if not awareness) with fundamental "which path" choices. Quantum mechanics is younger sister of computation

- Jacob Bekenstein - Holographic paradigm from black hole thermodynamics - all info of reality coded into 2 dimensions!
- Stephen Wolfram and Konrad Zuse - reality is a "cellular automata" at foundation starting with a simple rule deeper than physics Grand Unification theories.
- Donald Hoffman - there is no 3rd dimension at all! Our reality is all two-dimensional. All of reality is a fitness algorithm.
- David Deutsch - computation is THE foundation of reality. A "constructor" must exist like in Java code. Multiverse advocate. Multiverse = "dual" reality (mind or "realm of infinite" is separate from brain).
- Lee Smolin - all realities (Universes) evolve from prior ones in eternal evolution toward complexity and fecundity (via more Black Holes after every big bang).
- Various cosmologists – Inflationary (nested) multiverse and Black Hole event horizon as equivalent to cosmic horizon.
- Various biologists - Nature appears to be algorithmic and a "distributed intelligence" using any tool it can (over billions of years) to ensure survival via variety, fecundity, complexity e.g., photosynthesis using path optimization aspects of Quantum Mechanics and slime model problem-solving.

Thus, in attempt to tie together all of these concepts, perhaps all of reality is an algorithm that requires at least an initial bootstrap of intelligence (a la a "toe dip" into a dual world). Reality is two-dimensional with time and THE simple function of "add at least two units of memory, cut or not-cut (combine), and repeat." In a manner, man might therefore actually be "created in the image of God" as Nature appropriates reality's bootstrap code that, used with a complex enough brain becomes what we call and experience as consciousness.

The above model is obviously speculative so, perhaps, we can find additional supporting evidence in our world. The following observations attempt to bridge the gap between the self, in our minds, and the physical world, in our Universe, using memory.

In terms of our human brains, serotonin becomes a key mechanism. We can envision a model of human behavior driven by changes in serotonin (from medicine, environmental histamine, or bodily bipolar cycles) that result in changes in the mind's amount of working memory. These changes lead to variations in mental cut and combine (not-cut) operations that are the precursors to creativity and, thus, intelligence. When serotonin is low, there is reduced working memory. In this phase we see OCD, anxiety, and depression behaviors. When serotonin is high, there is hyperactivity and even mania. But, in the up and down slopes in between the peak and nadir, we have changes in the size of working memory (Figure 7). Humans will repeat a song over and over again when working memory is small and they will work to map out entire systems and find "associations across boundaries" when working memory in the mind is large. During the ebb and flow of working memory, we can envision the human mind making associations, pattern matches, or analogies i.e., intelligent behaviors.

"Norepinephrine and serotonin have been consistently linked to psychiatric mood disorders such as depression and bipolar disorder" as noted on WebMD [4]. Thus, imagine a patient with a bipolar diagnosis whom, in a low serotonin phase, has a small window of working memory and thus ruminates over and over again on a negative outlook that leads to a suicide. In this phase, the patient is unable to conceive of longer term turns for the positive or of big picture outlooks or perspectives.

Serotonin is also linked to consciousness via anesthesia. Tiger et al. in their 2020 research Ketamine Acts by Boosting Serotonin 1B Receptors state that "researchers found that the therapeutic effects of ketamine were due to inhibition of serotonin action [5]." Wikipedia notes the "biochemical mechanism of action of general anesthetics is not well understood... Potential pharmacologic targets of general anesthetics are GABA, glutamate receptors, voltage-gated ion channels, and glycine and serotonin receptors [6]."

Additional observations of anesthesia being linked to serotonin lead to a grand claim that consciousness is just (or is the experience of) changes in working memory size. This model may even lead to a different approach toward Artificial Intelligence noting that the discussed sizes of working memory, stored long term memory, and sensory inputs are large.

Numerous studies have reinforced the role of serotonin in memory, anesthesia (consciousness), creativity, and bipolar disorders. PsychGuides.com states that obsessive-compulsive disorder (OCD): ...is triggered by communication problems between the brain's deeper structures and the front part of the brain. These parts of the brain primarily use serotonin to communicate. This is why increasing the levels of serotonin in the brain can help to alleviate OCD symptoms [7].

Sadasivan Chinniah et al. in their 2008 research note:

Serotonin (5-hydroxytryptamine, 5-HT) is a monoamine neurotransmitter... 5-HT is involved in a number of physiological systems of relevance to the anesthetist... [t]he exact sites and modes of action of 5-HT remain ill-defined and elusive. A CNS deficiency of serotonin is thought to be key to the etiology of depression, and selective 5-HT reuptake inhibitors (SSRIs) are the first-line pharmacological treatment. SSRIs augment 5-HT concentrations at the synaptic cleft [8].

Gwen Smith et al. note in their 2017 research note:

Lower serotonin transporter binding was associated with worse performance in verbal and visual-spatial memory in mild cognitive impairment. ... "Now that we have more evidence that serotonin is a chemical that appears affected early in cognitive decline, we suspect that increasing serotonin function in the brain could prevent memory loss from getting worse and slow disease progression." ... [R]esearchers found that people with mild cognitive impairment had up to 38 percent less SERT detected in their brains compared to each of their age-matched healthy controls. And not a single person with mild cognitive impairment had higher levels of SERT compared to their healthy control. ... The researchers then compared the results from the brain imaging tests for the serotonin transporter to those two memory tests, and found that the lower serotonin transporters correlated with lower scores. For example, those people with mild cognitive impairment had 37 percent lower verbal memory scores and 18 percent lower levels of SERT in the brain's hippocampus compared to healthy controls [9].

Svob et al. note in their 2016 paper that:

The current evidence implies that reduced 5-HT neurotransmission negatively influences cognitive functions and that normalization of 5-HT activity may have beneficial effects, suggesting that 5-HT and 5-HTR represent important pharmacological targets for cognition enhancement and restoration of impaired cognitive performance in neuropsychiatric disorders [10].

Sasaki-Adams et al. note serotonin as having greater significance in brain functions than, and even controlling, dopamine:

There is ample evidence for serotonergic influences on dopamine function. ...For example, a number of in vivo microdialysis studies have clearly shown that exposure of the striatum or nucleus accumbens to serotonin results in increased release of dopamine (Benloucif and Galloway 1991; De Deurwaerdere et al. 1996; Hallbus et al. 1997; Parsons and Justice 1993; Yadid et al. 1994; Yoshimoto et al. 1996)... 5-HT_{1B} and 5-HT₃ agonists tend to facilitate dopaminergic effects (De Deurwaerdere et al. 1998; Parsons et al. 1996) [11].

In summary, this model proposes that Nature copied the boot code constructor algorithm of the Universe to make intelligent minds. Human minds are, thus, by all measures, each essentially a unique universe. Recently cosmologists discovered the equivalence between Black Hole event horizons and the cosmic information horizon. Thus, perhaps, one day human minds will be found to be equivalent to a primordial "cosmic mind," i.e., *a dream within a dream* indeed.

Now, let us consider again the "cut and combine" aspects of the boot code. Note that if you see an apple, you think about it for only so long. Why? Why not obsess over it and just stare at that apple and think of nothing else; look closer and deeper: microscopic, atomic, sub-atomic. So why don't we do this more often? Consider again that Nature steals anything and everything it can to allow gene pools to survive now or in the

future. This paper proposes that Nature stole the boot code of the Universe. But how does that turn into a human conscious "experience"? Nature uses or borrowed awareness (consciousness), to, at the very least, bootstrap the process, as noted with the first step of the boot code requiring an intelligence or awareness for the first *primordial cut*. But how does that represent me, as a human, not thinking forever about the apple? Nature, per the boot code, needs awareness, then memory, and then the cut or combine change actions. Now serotonin is a key, if not the key, to human memory as noted above. But serotonin levels, whether by design or not, exist in cycles; they are constantly changing levels. Thus, because the serotonin level of humans are constantly changing, our working memory level is also constantly changing and, thus, we lose focus of the apple. Our conscious experience of a present moment or a *now* (generally measured to be sub-second in duration) thus correlates to the biochemical rate of change in serotonin levels in a human brain.

But now let us replace the apple with a photon or an electron and we have a direct analogy to key aspects of Quantum Mechanics. The "cut" is the Heisenburg Uncertainty Principle (A or B, but never both), the "combine" is Quantum Entanglement (existentially unified into a single whole item), Quantum Superposition is only possible via constant unblinking staring i.e., no memory change, and Quantum Decoherence (collapse of the Schrodinger wave function) becomes synonymous, not with "interaction with the external environment" but, rather, the awareness's "change in working memory." The human mind is fundamentally unable to forever dwell on an apple, or photon, as it will innately be "distracted" via its brain serotonin cycle changing its amount of working memory.

Thus, our speculative model proposes that we might be able to unify Quantum Mechanics and Consciousness, in a single reality, via changes in the amount of working memory. In short, a possible proverbial Grand Unification via "memory change" as the existential operation.

Let us speculate further, again considering memory as a bridge between the Universe and minds. Note the abstract of Lawrence Steinman's 2004 paper *Elaborate interactions between the immune and nervous systems in Nature Immunology*, with special emphasis on the final sentence.

The immune system and the nervous system maintain extensive communication, including 'hardwiring' of sympathetic and parasympathetic nerves to lymphoid organs. Neurotransmitters such as acetylcholine, norepinephrine, vasoactive intestinal peptide, substance P and histamine modulate immune activity. Neuroendocrine hormones such as corticotropin-releasing factor, leptin and α -melanocyte stimulating hormone regulate cytokine balance. The immune system modulates brain activity, including body temperature, sleep and feeding behavior. Molecules such as the major histocompatibility complex not only direct T cells to immunogenic molecules held in its cleft but also modulate development of neuronal connections. Neurobiologists and immunologists are **exploring common ideas like the synapse to understand properties such as memory that are shared in these two systems** [13].

Here we see two ancient systems – animal nervous and immune systems - also bridged by memory. We can obviously generalize the nervous system as synonymous with, or the direct precursor, of mind. So we begin to see an existential triangulation. We can propose that when – and perhaps only when - we understand or can reverse engineer the human mind - likely by focusing on how the brain creates memory and on the exact workings of synapses and neurons in the brain - will we be able to reverse engineer the similarly complex entities of astrophysics from Black Holes to Quantum Gravity i.e., all are "cut from the same cloth." Note too recent papers claiming the entire Universe is a large "neural network" [14]. In essence, all systems are using the same mechanism of memory.

We are lead to a possible universal law where *all extremely complex systems use memory* – e.g., Universes, minds, nervous systems, immune systems, Internets, mainframes, genetic codes, etc.... Memory may even be the bridge to unify Relativity and Quantum Mechanics [15].

It is the authors prediction that once mankind understands how the brain creates mind (memories, experience, consciousness) that the solution to Quantum Gravity will soon follow via similar, if not identical, concepts and tools.

Figures

Figure 1.

An initial dream of an origin to reality via binary mathematics: "2, 3, 4, 5, etc. 0. Omnibus ex nihilo ducendis sufficit unum." (To make all things from nothing, unity suffices) from Gottfried Wilhelm Leibniz's imago creationis [12].

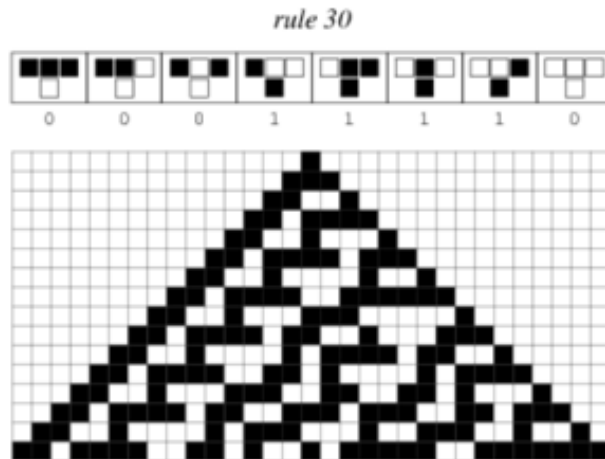


LEIBNIZ'S IMAGO CREATIONIS.

Source: Mutalik, P. (November 24, 2021). Why e, the Transcendental Math Constant, Is Just the Best. Quanta Magazine. Retrieved from: <https://www.quantamagazine.org/why-eulers-number-is-just-the-best-20211124> December 20, 2021.

Figure 2.

Cellular automata examples start with simple “a priori rules” (cuts or decisions) and then grow into complex patterns and structures; primordial rules determine the future evolution of structure.



Source: Rule 30 Cellular Automata image retrieved from Wolfram Mathworld. Retrieved from: <https://mathworld.wolfram.com/CellularAutomaton.html> on December 20, 2021.

Figure 4.

Visual representation of the constructor algorithm. Where, or in what "mind," lies the primordial memory units is the dualist assumption required in this proposal to bootstrap instantiate reality.

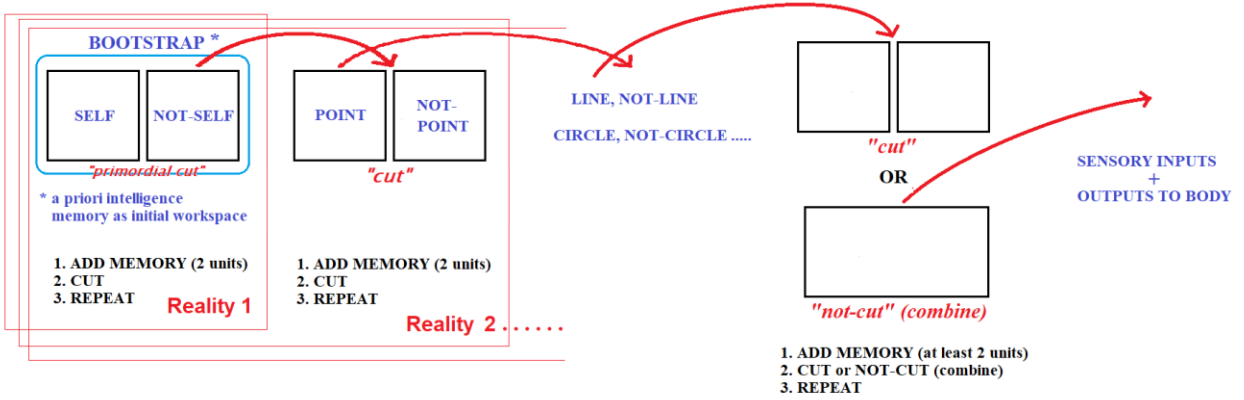
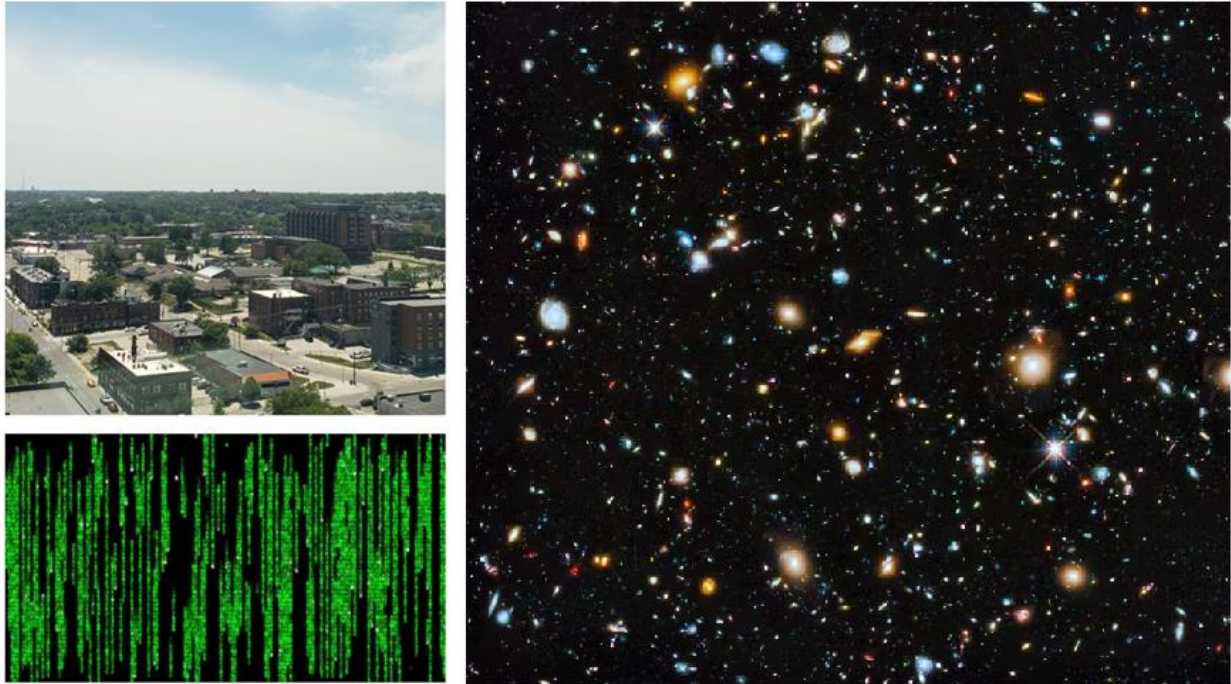


Figure 5.

Is the “reality” outside of our window – that is full of demonstrations of gravity, of the principle of least action, of Fibonacci Sequences, and of minds – just a vast repetition of “memory adds” and concept “cuts” or combines (“not-cuts”) scaling to the entire Universe?



Source: <https://www.indiewire.com/2017/10/the-matrix-code-digital-rain-meaning-1201891684/> and NASA\ESA\IPAC\Caltech\STScI\Arizona State University

Figure 6.

The minimal area of a two-dimensional "reality" encompassed using previously "cut" entities **line 1** and **line 2**, is a circle; they remain independent and not crossing. The boundary of randomness vs structure (e.g., maximum randomness = minimal structure) is the circumference of the circle. The length of the circumference is, thus, measured as diameter (line 1) $\times \pi$. The circumference, thus, defines the length required of **line 2** in order to create a boundary between our new concepts of **circle** (yellow region) and **non-circle** (blue region). Π , thus, is a simultaneous minimum and maximum "cut" border and, thus, is ever-present in our reality.

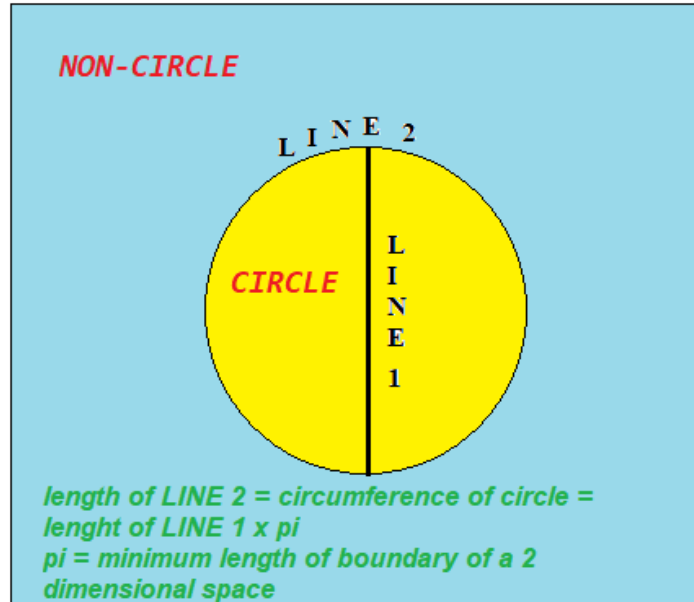
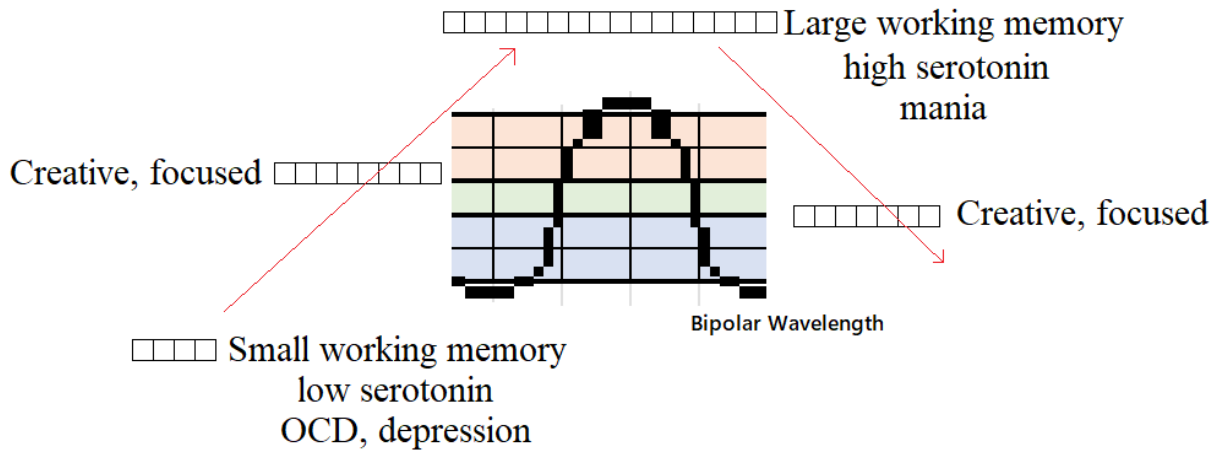


Figure 7.

The human brain's bipolar wavelength and intelligence (creativity) from changes in working memory via serotonin cycles.



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