

Is Reality digital or analog?

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Abstract

Reality is presented to us both in a digital and analog manner, the first as evidenced by the findings about the nature of space and sub-atomic entities, and the latter by the uncertainties at the quantum level. It is not sufficient to regard reality, our universe, simply as both but dialectically, one in terms of the other. The most fundamental law of understanding is that we apprehend something in terms of what it is not. We need contradiction to discern anything. Our understanding is process based and has deep historical roots extending back more than 4500 years. In modern times, scientists have relied upon Cartesian reductionism to discern the nature of our world, but deduction also is inherently dialectic, relying upon induction for its integrity. Logic, itself, is the language of innate order in the universe, but its digital aspect is bi-valency that describes what digital physicists have found to be the case in our reality. Evidence is in the form of how the syntax of the binary system and relationships within it reflect what happens here. Such has major implications for us in the form of inherent computations, phenomena as illusions, and complexity arising from simplicity.

The question

A brief answer to the 2011 WFXI challenge question, "Is Reality Digital or Analog?" is that reality seems to be both. The etymology of "digital" is "discrete," or distinct. "Digit" and its derivatives come from the Latin "digitus," meaning finger, the simplest form of expression being binary. "Analogue" refers to continuity - ἀνά, "up to" + λόγος "word, speech, reckoning," this etymology suggesting approximation or finding a likeness but not an exact match. An analogon is a comparison, hence, ratio. However, the distinction between digital and analog is expressed in more complicated ways, such as in particle versus wave and position versus momentum, the former of the pairs being the discrete and the latter continuous. Classical thinking focused on an "either-or" exclusionary description of something. Post Einsteinian thinking regarded the entity as both. A third way of thinking considers each but one in terms of the other.

Some problems inherent in answering the question and my caveats

This non-trivially awesome question focuses upon determining the nature of reality, and it would be arrogant to think that one would have a definitive answer. Inextricably bound to an answer are issues such as epistemology (how we know), objectivity, and truth. The philosophical literature entangles one in endless debates about these, so while my reply to the question is not meant to be a contribution to that forum, I am aware of the basic issues not being finally resolved [1].

To claim what reality is flies in the face of Plato's famous assertions (cave allegory and divided line in the seventh book of *The Republic*, for example) that it only can be represented. Aristotle retorted throughout his *Metaphysics*, among other places, that reality is in front of us. Neither philosopher

provides anything more than speculation. If people know what reality is, they should be able unequivocally bring others to the same conclusion. Yet, this is not the case, or the question about the nature of reality and whether we are in it would not be persistent now. Not being certain shouldn't stop us from moving ahead with an answer, for if our world is real, then so our answer should be. If it is something else, then, it will not bring us any closer to being there. Physicists have their ways of attempting to ascertain its nature, these being riddled with complex mathematics that seems to have yielded only more questions. Perhaps my method using the philosophy of logic can offer a productive route. If I end up where the physicists have, at least it might elucidate some matters where digital physics may have been lacking. I add my philosophy of binary logic because I consider it different; no one to my knowledge has presented my approach to answering a question like this before. I cannot worry about whether my answer is "absolutely" right or wrong, for whatever comes after me probably will be the determinant of that. Yet, it may be a key to finding a meaningful answer. My suspicion is that the question will linger long after I am gone. We still are confined in the proverbial philosophical fishbowl, looking from the inside out without benefit of perspective or reference frame. The exercise inherently is solipsistic.

I will for convenience skirt the rat's nest of epistemological debates by bootstrapping, the tool that logicians use and one that is consistent with the idea of digitization, i.e., analysis. This approach will become clearer as we proceed. To me "reality" can mean "universe," as philosophers from the ancients to the moderns seem to think that something called "the universe" is, in fact, reality.

Let us descend like Orpheus down to Eurydice to retrieve our other. Once we come out into the sunlight of Plato, we should not look back to the shadows of all the prejudices and human constructs of reality, lest the journey be all in vain. We begin with how we are going go there.

The most fundamental law of understanding

In front of us is a panorama of phenomena that we want to call reality. Is what makes it up discrete or continuous? Besides focusing upon a phenomenon as an object of understanding, I reflect on the process in apprehending it. We are often caught up in – no, I'll say obsessed with objects as objects. Naïve observers have no sense of context or history. After drawing something on a blank chalkboard, I used to ask my students how they knew what I drew was there. They would answer "because you drew it," "I see it," and so forth. I would turn out the lights and ask, "What do you see?" "Nothing," the students usually would say. I would ask, what would happen if they were placed in an environment in which everything is the same shade of a color. The same answer would come back. Only after much prodding would they see that without distinction, contrast, or contradiction, one apprehends nothing. Distinguishing something and its "other" is the core process in discerning what is in our environment. This is the fundamental law of dialectics, the realization of something in terms of what it is not, resulting in a peculiar form of mutual containment. It is just as much a law as is the law of gravity.

Such is a process, a way of knowing which ancient philosophers in South Asia knew 4500 years ago. The *Creation* hymn in the *Rig Veda* says, "Whence all creation had its origin, he, whether he fashioned it or whether he did not, he, who surveys it all from highest heaven, he knows--or maybe even he does not know. [2]" For Samkhya, the oldest form of Hinduism, the soul (purusha) is counterpoised against matter (prakriti), one in terms of the other; neither has it own identity in isolation. In the West, it is the dualism of mind and matter.

In the Samkhy philosophy, everything started with an eternal unconscious as the universe and from it unfolded everything we have today. From a whole emerges diversity, a law of cosmic order (*rta*), according to the Rig Veda. In the Vedic view [3], creation emanates from the self-consciousness of the primeval being (Purusha) that modern philosophers of consciousness could equate with the universe, the universe, itself, being conscious [4].

A world emerging from the inchoate also is told of in ancient Western philosophy. Hesiod (ca. 750 and 650 BCE) wrote of everything being born of chaos [5]. Others, such as Anaximander (c.610—546 BCE), stated, “...some other nature which is indefinite, out of which come to be all the heavens and the worlds in them.[6]”

Lucretius (ca. 99 BC – ca. 55 BC) stated that without differentiation there could be no harmony, i.e.:

In that long-ago
The wheel of the sun could nowhere be discerned
Flying far up with its abounding blaze,
Nor constellations of the mighty world,
Nor ocean, nor heaven, nor even earth nor air.
Nor aught of things like unto things of ours
Could then be seen--but only some strange storm
And a prodigious hurly-burly mass
Compounded of all kinds of primal germs,
Whose battling discords in disorder kept
Interstices, and paths, coherencies,
And weights, and blows, encounterings, and motions,
*Because, by reason of their forms unlike
And varied shapes, they could not all thuswise
Remain conjoined nor harmoniously
Have interplay of movements.* But from there
Portions began to fly asunder, and like
With like to join, and to block out a world,
And to divide its members and dispose
Its mightier parts--that is, to set secure
The lofty heavens from the lands, and cause
The sea to spread with waters separate,
And fires of ether separate and pure
Likewise to congregate apart [7]. (emphasis added)

All these writings have one thing in common, a description of a whole and parts coming from it. Yet, looking at a whole is not possible without looking at its parts and *vice versa*. Indeed, this recursive property is represented by figures such as the Moibus Strip, Necker Cube, and Klein Bottle; they illustrate the nature of dialectical symmetry. It would not be surprising to see time in this way, where future can influence the present, as the present can influence the future [8].

Are these accounts of our universe emerging from the unformed so far from the modern concept of our universe having its origin in a singularity, where the four basic forces of nature – strong, weak, electromagnetic, and gravitational – were as one, where there was no distinguishing anything, a

continuum? These are forces, or processes were bound up with the singularity giving rise to our universe and thus are its essence. There appears to be a deep structuralism in thinking throughout history, starting with Hindu Brahma, Vishnu, and Shiva corresponding to the inchoate – potential for creation, the whole that emerges from chaos, and division – or destruction.

The analytical method for answering the question

To produce a distinction in an undifferentiated whole, we simply could point to what our universe is not, such as another entity in an environment of multiverses, a highly speculative exercise. Another whole universe such as ours can be added, but this still would not take us any closer to comprehending what we have presently.

To arrive at building blocks of our world, we start with Descartes (1596 – 1650), who, continuing on the path of the ancient philosophers about cosmology, talked about the beginning of the world coming from “...no other form than that of chaos. [9]” His method of understanding was to “...to divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution, [10]” by showing that we cannot conceive body unless as divisible;” [11]. To look at the totality of phenomenon around us, we analyze it, or cut it up. It is a bootstrapping method that alleviates the solipsistic, or fishbowl problem alluded to at the beginning of this essay. A standard method of proof is assuming and seeing what conclusions follow. This deductive Cartesian method is digitization – making something discrete from the whole. The process is just as much a part of the object as the object, itself. It is truly dialectic. Welcome to digital physics.

Subdivision towards an infinitesimal leads to quantum states and an equal amount of uncertainty of the same quality as met by attempting to effect the dialectic by adding a universe to ours. Yet, we can accomplish addition by the Cartesian method. That you add by division is an apparent paradox. However, dialectics is like that, where paradoxes often are removed.

There is a *caveat* here. In logic, uncertainty lies with both analysis, or deduction, and synthesis, bringing together entities to form something new. With the first we identify definitions, rules, and primitive expressions by which the analysis can be made, but Gödel demonstrated that that there will be statements about natural numbers not provable within that system (also expressible by logic), and the consistency of the system cannot be demonstrated from within that same system. With induction, one does not know the realm of the unknown universe from which new elements are introduced. Yet, when we think we are seeing continuity, it is the rods and cones in our eyes as discrete sampling devices that provide the basis of our visual induction. Both deduction and induction, then, are not closed systems. We should not be prevented from discovering how deduction can describe our universe, however.

Logic as a language of order is indifferent to whether there is a world of shadows or reality. As a hallmark of empiricism and scientific methods, the process is repeatable, accepted, and used. Whether our world as a shadow or “reality” is answerable or not, it is, nonetheless our world. Our bootstrapping approach now will treat what we have around us phenomenologically as “real.” With hypothetico-deduction [12], we can start with a hypothesis based on theory, test it, and see what results. The manner of testing what it produces still is in the realm of theory in many respects, but there is sufficient information to think that the conclusions merit at least a further exploration, if not acceptance.

The result of the analysis

Logic is a process, an interplay between digital and analog, the former being discrete (analogous to a particle) and the latter being continuous (analogous to a wave). The dialectical aspect of logic, deductive as digital and inductive as analog reflects this. To appreciate this interplay, it is helpful to review the relationship between continuity and particularity.

The problem of continuity is as old as Zeno's (ca. 490 BCE? – ca. 430 BCE?) paradox of the tortoise and the hare, where two objects coming together never can touch, as no one can stop subdividing the distance between them. Of course, this issue was overcome mathematically by calculus and the convergent series. Yet, a fundamental precept of calculus is the idea of limit, something set by a human. For example, approximating the area of a circle depends upon how precise we want pi, the ratio of the circumference to the diameter, suggesting that pi represents a process displaying a relationship, rather than a number. We decide how close to a boundary, or limit, the value of a function is to be and set how close to a value we want the function to approach. That is, the limit depends on us. Another example is determining the area under a curve, where set the size of the polygons we want to approximate the area. A boundary, itself, is problematical at best, but at the quantum level (as in the double-slit experiment, where an attempt at measurement destroys the interference pattern), a human seems to determine reality. In measuring anything; one has to know the degree of precision required, and this is set by the one doing the measuring.

It is appropriate to interject the boundary issue in determining the extent of our universe. A limit may not always be a physical edge but a process, such as Feynman's "Character of Physical Law" [13] framing an edge. Here, a process is the limit, the speed of light allowing us to see across a distance of about 46.6 billion light years or 8.80×10^{26} meters. It is conceivable that it may be larger, but such would involve getting outside the current dimension or going faster than the speed of light, and transcending time.

Now comes the simplest form of measurement in dialectic form, a measure of two - binary logic, the most basic form of being digital. It is two things. First, it is the language describing innate order in the universe. Second, within this language itself are processes that are found in the universe that have been discovered by other methods of inquiry [14]. The idea that the universe is binary is not new, as widely diverse scientists such as Wheeler [15], Wolfram [16], and Piaget [17], among many others, have argued, but how far does this idea carry in our ability to apprehend our environment that we take to be reality? More succinctly, is reality that of "it from bit," or is it continuous?

We now make a decision of how far subdivision is to be made before there is little utility in going further. Mathematical physics reduces us to the world of Planck volume in a world of vacuum space that allows virtual particles to come in and out of existence. Beyond this distinction seems to disappear, and we truly are at where we were in attempting to discern boundary for the universe. Again, the dialectic manifests itself, the Planck world being defined in terms of the largest of all, the universe. At both extremes is uncertainty as to size, and it seems that only that the character of physical law as a process provides us with any way of assessing a boundary, one that emerges concurrent with our ability to measure.

Then, what is the dialectic "other" of Planck volume (4.22419×10^{-105} m³)? If Planck volume is one aspect of the dialectic underscoring our binary world, then we look at vacuum space as the other aspect.

Loop quantum gravity says that the space is, quantized, i.e., discrete. This idea isn't new, as Zeno of Elea said:

The arrow which is moving forward is at every present moment in a space equal to itself, accordingly it is in a space equal to itself in all time; but that which is in a space equal to itself in the present moment is not in motion. Accordingly it is in a state of rest, since it is not moved in the present moment, and that which is not moving is at rest, since everything is either in motion or at rest. So the arrow which is moving forward is at rest while it is moving forward, in every moment of its motion [18].

The key words are “every moment of its motion,” indicating a discreteness of space. Modern physicists, such as Zizzi, also argues for space being discrete [19]. Planck volume is in terms of vacuum energy, a fundamental binary and dialectical relationship [20].

At and below the Planck scale, we are in the realm where all four forces seem to be unified and even time, itself, lacks. At such point, we barely can even talk about a binary world, but we seem to reasonably sure that this is the scale at which everything in our universe started as the singularity. Time no longer appears relativistic, as everything is one, the singularity. Hence, to for binary expression, we stop at the Planck scale with a unit of Planck volume in terms of vacuum space.

What the language of binary logic tells us about our universe.

Two of my favorite aspects of binary logic illustrate the power of that system to express the nature of the universe. First and foremost is the primary inference relationship in logic: “If something, then something.” Logic instructors often tear their hair out in explaining this “material implication” operator, the truth table of which is,

p	q	p \supset q
0	0	1
0	1	1
1	0	0
1	1	1

where 0 = false and 1 = true. Ordinary language translations of the operator have given logicians such a fit that modal logic was born [21]. However, there is a consistent interpretation, as indicated by the word “containment,” stated in several ways. It is clear that elements contain themselves, and if we consider “0” standing for potential information, an unknown, or an origin (perhaps vacuum space), then, it can be seen that it is true that 1(Planck volume), representing a known or information, emerges from that 0. However, “1” standing for potential information cannot go backward and itself become the unknown; once it is known, it is known. As 1, something coming from an origin 0 does not produce that origin, although it can be the origin for something else. The 0 can stand for the undefined, or chaos, and 1 as order. The 0 can remain itself as 0 or generate order as 1. Order does not generate chaos. The 1 can be itself or generate order. In cosmological terms, we may treat 0 as a singularity, the inchoate, as in the Vedas, Hesiod, and Lucretius, and 1 as the universe emerging from that chaos.

In returning to recursive representations of our universe, such as the Klein Bottle [22] we find that such recursion is represented by the sixteen functions comprising basic logical space. Two basic entities,

let's say represented by p and q, bear a permutation of four relationships between them, as indicated by the truth table above. From this extends the sixteen four-place functions in the following manner, known commonly as the Table of Functional Completeness, namely,

p	q	f ₀	f ₁	f ₂	f ₃	f ₄	f ₅	f ₆	f ₇	f ₈	f ₉	f ₁₀	f ₁₁	f ₁₂	f ₁₃	f ₁₄	f ₁₅
0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
0	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

When the outputs of each of these functions are forward-fed as inputs, the function will repeat itself. Perforce, because our universe is binary digital in character, and spaces are comprised on one or more of these sixteen functions, space is recursive [23].

There are many more processes within the binary system that describe our universe, but space now only allows me to move to what some of the implications are.

Implications of the answer that the universe is digital

Our path of descent has reached a world containing entities that would take more energy than is contained in the universe to split them. It is where matter is mind and vice versa. It is Aristotle's substratum out of which everything comes. It is the world of quantum processes and no thing is reality with any lasting quality. Only process seems to be reality, where the Hindus say that all is maya, or illusion. All phenomena are comprised from this substratum, and it is in constant flux. It appears that knowing, knowledge, and, everything else – even ideas – at this level are uncertain. Uncertainty describes reality. Boundaries clearly have no identity. At the Planck scale, only Feynman's "Character of Physical Law" exists, where it is process that that determines what is. It is not that the universe is such and thus but only what that physical law allows it to be, regardless of whether we are able to apprehend it empirically.

Here, computations are implicit just by the nature of binary space, as in cellular automaton and the mere juxtaposition of fundamental binary functions so as to produce others. Unfolding from these arrangements are patterns, or regularities that allow one to ascertain what will happen if there is a continuation of those arrangements, as illustrated by "gliders" in cellular automata and fractals. Even a reputedly random juxtaposition of functions reveals patterns [24]. It is plausible that all complexity obtains from the simplicity of the binary world [25]. It is becoming clear that simplicity often translates itself into complexity, as suggested by Turing's reaction-diffusion model expressed by patterns in nature [26]. Indeed, one example of the markings on a typical conus textile snail shell is the same as discussed by Wolfram resulting from a simple cellular automaton [27].

What a digital universe doesn't seem to tell us at first is anything about time and our consciousness. As we look out over space and see distant objects, we know that these are in the past. Alpha Centauri is 4.37 light years away. We are seeing the sun as it was eight minutes ago. Carrying this process further, this "perceptual lag" is all around us, where even our neighbor is seen as she or he existed petaseconds or less ago. Going still further, we ask where does it stop; what is the focus of our consciousness? Perhaps it is not within us at all, but as Zizzi[28], Kafatos (cited above), and the ancients suggest, it is in the universe itself. It may be that ideas are passed in and out of the universe to and from another

dimension. Again, one should be reminded about the meaning of boundary. Perhaps there is something about that character of physical law that accounts for consciousness, as well. If consciousness is immanent in the universe and each of us is merely partaking of it, then, we may need to think differently about the ego.

End words

In light of all that has been said, I conclude that the answer to whether reality is digital or analog is that dialectics frames the answer. An entity exists because of its other and vice versa. Digital is seen in terms of the analog, just as a particle, or discreteness has its existence in terms of a wave, or continuity. It is the same with deduction in terms of induction. I am reminded of the argument in Marcia Eliade's *Myth of the Eternal Return* about people regarding circular time as becoming linear with the advent of the written word. As I write this, and wonder, given dialectics and all I have said, whether, like the hoop snake or the closed timelike curve, I am just looking at my tail.

$$x \supset 0 \subset x$$

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