

Bridging the Universe and the Cognition

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Abstract—In this paper the following questions are answered:

- What is the cognition?
- Where does the cognition come from?
- Can we set up a theoretical framework that is similar to the physics for the cognition?
- Which one is the most essential, the Universe or the Cognition?
- Which one did exist first, the Universe or the Cognition?
- Is it true to say that the cognition is an emergent phenomenon from brains?

The theory presented in this paper is called the *Unicogse Theory*. In this theory, the “real” physical world(the Universe) and the “imaginary” cognitive world(the Cognition) are two coexisting and indispensable sub-Beings of the super-Being called the *Unicogse* (Universe+Cognition). The Universe and the Cognition are a dual pair. The cognition is not generated by a physical system such as a brain. Yet, a physical system with grounded logics, such as natural languages, can access the Cognition through a window between the Universe and the Cognition. Only a grounded logics such as a human natural language has the ability to bridge the Universe and the Cognition. Therefore, the cognition of a brain is not generated by a brain, it is “received” by the brain from the Cognition side. From this point of view, a human brain is a “sink” of a cognition while the “source” of this cognition is at the Cognition side, its natural language is the “antenna”. Copyright © 2005 Yang’s Scientific Research Institute, LLC. All rights reserved.

Index Terms—The Universe, the Cognition, the Unicogse, computational verb, physical linguistics, fuzzy theory.

“Imagination is more important than knowledge.”

“How can it be that mathematics, being after all a product of human thought independent of experience, is so admirably adapted to the objects of reality?”

“One reason why mathematics enjoys special esteem, above all other sciences, is that its laws are absolutely certain and indisputable, while those of other sciences are to some extent debatable and in constant danger of being overthrown by newly discovered facts.”

Albert Einstein(March 14, 1879–April 18, 1955)

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This paper is dedicated to Albert Einstein—the last giant in sciences.

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I. INTRODUCTION

CAN COMPUTER understand the meaning and truth at the cores of natural languages? Before I can answer this question, I should make it clear that what in my mind is the next generation of computers. The next generation of computers consist of the following two kinds of important components:

- 1) A body full of artificial sensors such as e-noses, force sensors, vision and audio sensors.
- 2) In the core of the future generation of computers, locates a part called *machinself* where human programmers have no access to. A machinself is equivalent to the human subconscious part of mind.

How to build this kind of computer? Well, we can grow it just like what we do to our pets. Based on the technologies that we already have or will have in the near future, the molecule self-assembly technology can be used to build the machinself of this kind of computer. Therefore, this kind of computer will need to take chemicals as their energy sources and might still need electrical energy. Only the computer with machinself can be used to implement an emotional world, an intuitive reasoning engine and a creative ability.

So far I only talked about the device level—the hardware level of building a computer with a machinself. Before we can use this kind of computer to perform a specified task, another problem should be solved; namely, how can we gain control over or instruct a machine with its own *machinality*(from machine’s personality)? The answer is to use the same methods we are using for the purpose of educating children. We will need to educate the future computers instead of programming them as we do today. In the future, these computers will form a relatively independent society where some smart computers will serve as teachers to educate new-born computers. After go through the computer school system from low level to high level, a computer will be tested and given different licences for different tasks such as home management, baby sitter and computer teacher. The education process for the entire computer society is continuous and endless and their intelligence will be initiated by human individuals using natural languages.

If a future computer cannot understand natural languages, we can not educate it efficiently. At the very beginning a machine will misunderstand a natural language in a very complex way. Well, it is not necessary for a machine to understand our languages as we do. If a machine can associate a correlation between what we mean and what it thinks, the communication between machines and human individuals is then begin to establish at the intuitive level. Although in today’s computers natural languages are processed mostly as database and the structure of this database based on rules, it will not be the case for a computer with a machinself.

For a computer with a machinself, each word will trigger a complex machinself-sensor dynamic process, behind which lies the grounded logics.

At the near future, it is meaningless to pursue the goal of letting machine to “understand” us. In many cases we human misunderstand each others, how can we expect a machine to understand us? However, a machinself can have its own understandings of meanings in a natural language. Even a misunderstanding is better than no understanding at all. In fact, if I have a machine right now can misunderstand what I tell it in a consistent way, I will be very happy to apply it to many applications. A machinself is where new information can be generated from nowhere, like our intuition and creativity. Without a machinself, no matter how complex, how fast, how big the database it has, a computer can not generate new information. However, today’s computer can find new structures or new patterns in existing information. While this ability of today’s computers is very useful, for example, to build an Internet searching engine, no creativity can emerge out of it. Since our subconscious minds are the sources of new information, we can create new information from nowhere¹. In a machinself-sensor+actuator setting, the reality is the context that a computer can sense and act upon. It does not need to program it. Without a machinself-sensor+actuator setting, no meaningful emotional effect can be created in a computer.

Since we cannot program the machinself in a future computer, how can we interact with it? We need to develop a kind of language system that has the following properties.

- Can be easily understood by human beings and by the future computers; namely, this kind of language system must be context-dependent, yet hardware-independent.
- Can be measured. Every component in this language system must be measurable and can be grounded into physical hardware.

It is easy to understand that this kind of language system must be easily understood by both computers and human beings. Then why we need this kind of language system to be measurable? This is because any computers we can build must be measurable, otherwise, we cannot build them at the first place. Functioning as the interface between the computers and human beings, if this kind of language system is not measurable, then we can not implement it into computers. Let us take a few examples to address this issue. Since Boolean logic can be measured by inspecting a 0- or a 1-state at any temporal-spatial point, it can be implemented by digital computers. In fuzzy logic, the membership functions are measurable, therefore a language with only nouns and adjectives can be implemented by using both Boolean logic and fuzzy logic. This is the reason that we can implement nouns, which become measurable by using Boolean logic, and adjectives, which become measurable by using fuzzy logic, into digital computers. However, without using computational verb logic, verbs in a natural language are not measurable. This is the reason that we cannot implement verbs in computers

by using Boolean and fuzzy logics. Therefore, the language system used in the future computers must be a measurable platform for every grammatical components of an advanced natural language: nouns, adjectives, verbs, and adverbs.

Our goal is to build a linguistic system of which each grammatical component is measurable. We call the theory behind this kind of linguistic system as measurable linguistics, or *physical linguistics*[41], [42]. Since Boolean and fuzzy logics can be readily to make nouns and adjectives measurable, the rest of the story is to make verbs and adverbs measurable too. We use the computational verb theory to make verbs measurable.

As the first try of a paradigm shift for solving engineering problems using verbs, the computational verb theory and physical linguistics have undergone a rapid growth since the birth of computational verb in the Department of Electrical Engineering and Computer Sciences, University of California at Berkeley in 1997[27], [28]. The paradigm of implementing verbs in machines were coined as *computational verb theory*[41]. The building blocks of computational theory are *computational verbs*[36], [31], [29], [37], [44]. The relation between verbs and adverbs was mathematically defined in [30]. The logic operations between verb statements were studied in [32]. The applications of verb logic to verb reasoning were addressed in [33] and further studied in [41]. A logic paradox was solved based on verb logic[38]. The mathematical concept of set was generalized into verb set in[35]. Similarly, for measurable attributes, the number systems can be generalized into verb numbers[39]. The applications of computational verbs to predictions were studied in [34]. The applications of computational verbs to different kinds of control problems were studied on different occasions[40], [41]. In [45] fuzzy dynamic systems were used to model a special kind of computational verb that evolves in a fuzzy space. The relation between computational verb theory and traditional linguistics was studied in [41]. Some successful commercial applications of computational verb theory are *YangSky-MAGIC* card counter[10], *FlameSky* flame detecting systems[11], *DriveQfy* visual automatic system for driver qualify tests[12] and an intelligent traffic monitor and control system called *TrafficSky Project*[9].

In the summer of 2001, I began to think about generalizing computational verb theory into a more general framework called *physical linguistics*[41]. During my exploration of the realm of physical linguistics, I realized that two immediate applications of computational verbs to engineering problems; namely, (computational) verb controllers and (computational) verb image processing. I dedicated Chapters 6 and 7 of [41] to verb controllers and verb image processing, respectively. After my first attack to both engineering problems, I kept thinking about how to improve the existing results. For the applications of computational verbs to control problems, two papers reporting the latest advances had been published[46], [47]. For the applications of computational verbs to image processing, a credit card counting system with vision sensor, called *YangSky-MAGIC*, had been developed[10]. During the R&D of this product, I realized that computational verb theory has a much stronger ability than I originally thought. This

¹As addressed in [42], this kind of new information is in fact comes from “nowhere” in the Universe, yet it does come from “somewhere” in the Cognition that is the twin of the Universe.

further pushed me to think about why computational verb theory seemed to fit into human cognition seamlessly.

In the Fall of 2004, I realized that it is impossible to build a measurable linguistics without building a measurable cognition first. And the measurable cognition, if exists, must be independent of a particular human brain, otherwise it will be out of the scope of sciences. This challenge leads to some amazing results including the finding of the Cognition as the twin of the Universe and the measurements of truth in the Cognition. I realized that the Cognition is an indispensable dual of the Universe and human brains are special interfaces to bridge the Universe and the Cognition. I also realized that any logic or language system is in fact a medium for truth to travel, just like water and glass are mediums for light to travel. These ideas changed dramatically my view points towards the Universe and myself. I realized that human beings are not the only being to interface the physical Universe with the Cognition and any being can serve this purpose as long as it has grounded logics or natural languages. This further shows that for a system to have cognition is irrelevant to whether this system is alive or not. Put it the other way, *cognition is not the unique phenomenon for living creatures like us*. Instead, for any being or thing, if it can open a window toward the Cognition from the Universe side, it must have cognition.

During my career as a researcher of nonlinear dynamic systems, I had developed a feeling that the cognition should be patterns generated by the nonlinear dynamics in a human brain, therefore, it must be a phenomenon, a pattern, not a “real thing”. Therefore, it became very uncomfortable to face a cognition out of a brain. Suddenly one day I realized that to think the physical Universe being more important than the Cognition is only because my brain is physical! How about my brain is not physical, say, a brain in the Cognition? Should a brain in the Cognition also think it is more important than a physical brain? After I put my physical brain at the same level side by side with its dual system in the Cognition, I feel much easier for me to develop a system of metrics in the Cognition and the method to measure cognition. Unicogse is exactly the basis for building a measurable cognition and furthermore a measurable linguistics.

To make my point clear, let us play a game of exchanging the roles of physical Universe and the Cognition. Let us assume that we are doing a physical experiment in a dream. Our task is to measure the mass of a rock in the dream. Since this is a dream, nothing is physical. Therefore, the rock in the dream is in fact nonexistent. However, we can still believe that we can feel the mass of the rock. The only difference between the real experiment and the experiment in the dream is that in the real experiment we measure a physical mass, however, in the dream we measure the belief of a mass which is the mass of a TRUTH.

Let us push this mental experiment one step further. Assume that there is a twin of mine living in my own dream, then what is my Universe from his eyes? In his world, he has only two things: Information and belief. He has no physical things in his “real” world. Therefore, he can only feel physical things in his dreams which are projected to my side—the physical side. However, his dreams will have consequences in my physical

world. For example, if in his dream he is 100% for sure seeing a chair, then a real physical chair must appear/exist in my real physical world. If he is only 50% for sure seeing a chair, then something 50% similar to a chair must appear/exist in my real physical world. Therefore, somewhere between my real physical world and the cognitive world of my imaginary twin lays an interface that can change my physical mass into his belief, and change his belief into my physical mass. Since this interface must be between my physical world and his cognitive world, it doesn’t belong to my physical world neither his cognitive world. Then where should we put this interface? There must be a container for physical world, cognitive world and the interface in between. This container is the Unicogse.

The conclusions in [42] show that logics and languages are entirely measurable in the world of my imaginary twin while any physical things are “imaginary” in his world. From this point of view, the physical linguistics is in fact the very “physics” in his world. As long as I feel comfortable to exchange my own position with that of my imaginary twin, I can measure the “size” of TRUTH and the “mass” of information in his world using mental “equipments”. That the role changes back and forth between physical measurements and mental “measurements” is the only way to build a measurable cognition theory. Physical linguistic will be developed in such a measurable cognition.

II. UNIVERSE-COGNITION DUALITY

In this paper the duality between (energy, matter)-pair and (verb, noun)-pair will be studied in the context of the coexistence of the Universe and the Cognition. Matters are BEINGS and energy are BECOMINGS in the physical world, while nouns are BEINGS and verbs are BECOMINGS in the linguistic world. If a natural language is really a cognitive model of the physical world, then there must be some traces of one-to-one mappings between the physical relations and linguistic relations. The main goal of this paper is not only to reveal these one-to-one mappings but also set up the much stronger connections between the linguistic world and the physical world by set up the duality between (energy, matter)-pair and (verb, noun)-pair. Furthermore, the coexistence of the Universe and the Cognition since the Big Bang provides a much more universal theoretical framework for physical and cognitive worlds. In the Cognition, the fundamental duality of physical energy is TRUTH. By rooting the (energy, matter)-(verb, noun) duality into the energy-TRUTH duality, the global picture of the measurable structures of the Cognition can be revealed and formalized. The most basic aspects of the system of metrics in the Cognition will be also provided. Based on this system of metrics, we can measure the velocity, the distance, and the size of TRUTH. The measurement of TRUTH constitutes the beginning of the measurements of different cognitive systems including human brains as a subset. The last important conclusion of the paper is to realize that the Cognition is independent of human brains; namely, human brains are only one special kind of cognitive structure. In the Universe, there can be many, if not infinite, possible cognitive structures in different sizes, structures and working principles.

The signature of a cognitive structure is the interfacing ability between the Universe and the Cognition. Since I am writing this paper at the Universe side, I believe the interface from the Universe side to the Cognition side must be physical, like my brain. However, if we follow the duality between the Universe and the Cognition, there must be some structures, which are not physical, at the Cognition side to interface the Universe. For us, the human beings at the Universe side, the Universe is the reality as addressed by Einstein. However, this doesn't to say that the Cognition is the shadow of the Universe. Since the Universe and the Cognition are dual to each other, there is no master-slave relation between them, they are two facets of the same Universe-Cognition (Unicogse) at the high-level of our reality. This is the most profound conclusion of this paper, indeed.

III. ENERGY, MATTER AND TRUTH CONSERVATION

In current physical models, energy and matter are conserved in a closed physical system; namely, if a physical system has no energy and matter exchanges with outside worlds, then the total amount of energy and matter will keep the same forever. Only the forms and patterns of energy and matters can be changed in this closed physical system. The maximum range of such a closed system is the Universe. On the other hand, matter and energy are not two polarized concepts, they are just two facets of the same energy concept. From my point of view, energy defines the space and furthermore, the generalized synchronization between energy patterns forms different kinds of matters. Without energy, we can not perceive both space and matter. That the space is important to human cognition is because human brains happen to be matters. Therefore, the concepts of matter and energy as two separated axioms in human cognition is only because in this way we can handel them comfortably. I conclude that in cognitive worlds

- 1) The *energy of* BEING is known as matter in physics.
- 2) The *energy of* BECOMING is known as energy in physics.

To distinguish both types of energy is the first step towards setting up the duality between the concept of energy in physical world and the concept of *truth* in linguistics, and furthermore the TRUTH, which is the duality of energy in the Universe, in the Cognition. Let us first set up some axioms.

Axiom: The physical *energy* and linguistic *truth* are dual. (1)

We use energy \leftrightarrow truth to denote the duality between energy and truth. Be using this duality, we have the following axiom

Axiom: A closed linguistic world is truth conserved. (2)

This axiom is of course easily to verify in any formal logic system where the truth must be conserved. As to natural languages, this axiom might not be that obvious at the first place. Well, this is the work that physical linguistics need to figure out. The physical duality of Axiom 2 is the energy conservation in a closed physical world.

As it will become self-evident later in this paper, the terminologies of the *truth of* BEING and the *truth of* BECOMING

are used here without addressing their meanings. Based on Axiom 1 we immediately have

- 1) truth of BEING \leftrightarrow matter;
- 2) truth of BECOMING \leftrightarrow energy.

The truth of BEING and the truth of BECOMING are the truth of nouns and the truth of verbs, respectively. It is easy to figure out the truth of nouns because we already have tons of literature to address this issue. However, the truth of verbs was rarely studied by scholars. As I addressed in computational verb logic[32], verbs have no cognitive truth. At least, verbs have no truth in the way we familiar with. In [32] and furthermore in [41], I used the concept of verb collapses to transfer the truth of verbs into the truth of nouns. Therefore, a verb collapse[41] means that the truth of BECOMING can be collapsed into the truth of BEING. On the other hand, a verb extension[41] means that the truth of BEING can be unfolded into the truth of BECOMING. The corresponding linguistic evidences for verb collapse are that some verbs can gradually lose their dynamics and evolve into nouns or other grammatical components other than verbs while many nouns gain dynamics and become verbs. In physical world, the dualities of verb collapses correspond to energy changing its form into matter while the duality of the verb extension corresponds to matter changing its form into energy. Besides the verb collapse, verb similarity is a way to define the truth of verbs as used in verb rules[47]. However, this kind of truth of verb is in fact relative similarities between different verbs. It has no absolute physical meaning. Therefore we would rather like to restrict its applications to engineering problems.

IV. TRUTH VELOCITY AND COGNITIVE QUANTUM

Since the truth of verbs and the truth of nouns can be qualitatively "equivalent" by transferring their forms, this reminds us Einstein's most well-known formula

$$E = mc^2. \quad (3)$$

This essentially tells how many energy E can be released from a piece of matter M of a mass m . This equation points out that matter and energy are merely two different forms of the *same thing*. What is the *same thing* means? Is the *same thing* the matter or the energy or something other than matter and energy? Based on the biological structure of human body, it is clear to me that without energy, we just can not perceive any BEINGS. This tells us that energy is "more" essential. However, if we think about this chicken-egg problem, we immediately have some dilemma like "if without a BEING at the first place, where comes the energy to perceive?" To solve this dilemma, the only possibility is to introduce a third party as a higher level over energy and matter. I call this third party the TRUTH. As it will become self-evident later, the TRUTH is also the *same thing* in the Cognition, which is the duality of the Universe. Based on this argument, in the (physical) Universe, matter and energy can be called the TRUTH of *matter* and the TRUTH of *energy*, respectively. In the Cognition, the dual concepts are the TRUTH of BEING and the TRUTH of BECOMING.

Matters can be turned into energy, and energy into matters. By using the duality, verbs and nouns are also different forms of the *same thing*. Nouns can be turned into verbs, and verbs can be turned into nouns. The process of turning a verb into a noun is known as a *verb collapse*, and a noun into a verb is known as a *verb extension*[41]. If the (energy, matter)-(verb, noun) duality does exist, then what is the dual equation of Eq. (3) in the Cognition? Since the light speed in vacuum, denoted by c , is the speed limit of energy/matter travelling through the Universe, can we find the speed limit of TRUTH travelling through the Cognition via (energy, matter)-(verb, noun) duality? Let us write the dual of Eq. (3) as

$$\begin{aligned} \text{TRUTH in the form of BECOMING} \\ = \text{TRUTH in the form BEING} \times \tau^2 \end{aligned} \quad (4)$$

where τ is the vacuum velocity of TRUTH travelling through the Cognition. What is the vacuum in the Cognition will be discussed later in this paper. To find τ we need to consider the standardized settings as follows. Since it sounds a kind of funny if in physics we called matter as “energy in the form of matter” and energy as “energy in the form of energy”, to unify the terminology, let us recast Eq. (4) into

$$\text{BECOMING} = \text{BEING} \times \tau^2. \quad (5)$$

Therefore, as a dual to the pure energy in physics, BECOMING is the pure TRUTH, or the *absolute truth* in dialectics. This idea has a long history dated back to I Ching around 3,000 years ago and the Taoist master Lao Tzu around 2,500 years ago. Taoism believes that “change” is the *only constant*. Here this *only constant*, which is represented by TRUTH, is measured by BECOMING in different contexts.

Let the outer function of BECOMING be

$$\mathcal{O}(t) = b + (a - b)e^{-t}, t \in [0, T] \quad (6)$$

such that $\mathcal{O}(0) = a$ and $\mathcal{O}(\infty) = b$ where a and b are two constants and T is the life span of the BECOMING. The value of T will be given later. The membership function of the BEING is given by the following linear form

$$\mu(x) = \frac{x - a}{b - a} \quad (7)$$

such that $\mu(a) = 0$ and $\mu(b) = 1$. This makes $\mu(\mathcal{O}(0)) = 0$ and $\mu(\mathcal{O}(\infty)) = 1$.

Then we have

$$\begin{aligned} \text{TRUTH of BECOMING} \\ = \int_0^T \mu(\mathcal{O}(t))dt &= \int_0^T \mu(b + (a - b)e^{-t})dt \\ = \int_0^T \frac{b + (a - b)e^{-t} - a}{b - a} dt \\ = \int_0^T (1 - e^{-t})dt &= T + e^{-T} - 1, \end{aligned} \quad (8)$$

and

$$\begin{aligned} \text{TRUTH of BEING} &= \int_a^b \mu(x)dx = \int_a^b \frac{x - a}{b - a} dx \\ &= \frac{(b^2 - a^2)/2 - a(b - a)}{b - a} \\ &= \frac{3a + b}{2}. \end{aligned} \quad (9)$$

Note that in this case the universe of discourse of the BEING is chosen as the information space. Although the BEING has many different implementations in different universes of discourse in natural language, at the abstract level, it is better to choose the most abstract form of “matter”. I choose “information” as the most abstract matter in the Cognition. This is because any other BEINGS can be treated as a token of a piece of information.

Therefore, we have

$$\tau^2 = \frac{T + e^{-T} - 1}{\frac{3a+b}{2}}. \quad (10)$$

We need to define a system of metrics for the Cognition. Since the minimum information unit in a truth-conserving system is one *bit*, we set the following benchmarks: $a = 0$ and $b = 1$. This leads to

$$\tau^2 = 2(T + e^{-T} - 1). \quad (11)$$

We also need to define the concept of *cognitive quantum*, ψ , in order to find the life span T .

Definition 1. [Cognitive Quantum (of TRUTH) ψ]. *Given a cognitive medium, a cognitive quantum of TRUTH, ψ , is the minimum size of TRUTH that can be distinguished in the cognitive medium.*

Remark: How can we know that a TRUTH has a high degree of truth than another TRUTH? I guess we use some cognitive abilities. Since the intrinsic noises in neural systems, the cognitive quantum will be the tiny threshold above the background noise level for a neural system to distinguish different words in a natural language.

The life span T is chosen as the exact moment when the BECOMING hits the boundary of the last cognitive quantum to account for the whole truth, that is

$$1 - e^{-T} = \psi, T = -\ln(1 - \psi). \quad (12)$$

It follows from Eqs. (11) and (12) that

$$\tau = \sqrt{2\psi - 2\ln(1 - \psi)}, \psi \in [0, 1]. \quad (13)$$

The relation between ψ and τ are shown in Fig. 1. From this figure we have a few interesting observations as follows.

- 1) When $\psi = 1$, we model a cognitive medium with Boolean logic. In this case we get $\tau = \infty$. We know this is not the case for a human brain because we experiences that no matter how trivial a statement might be, to tell whether it is true or false, we do need some time. This proves, from the other point of view that the cognitive quantum of TRUTH in a human brain is less than 1. What does this mean? This means a human cognitive system uses multivalued or even fuzzy logics! On the

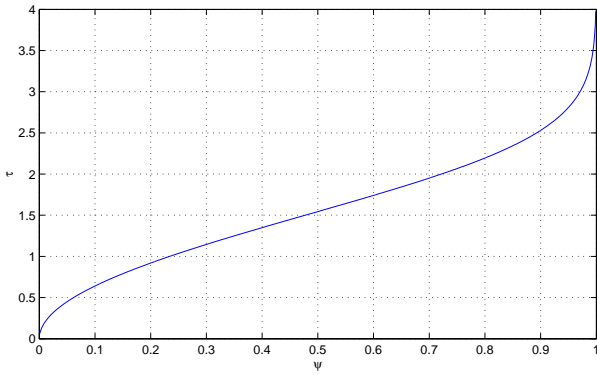


Fig. 1. The relation between the truth speed and the cognitive quantum in cognition.

other hand, this means that the logic operations based on Boolean logic can be finished as fast as the physical hardware allows. Since the maximum value of τ is the vacuum velocity of TRUTH, *Boolean logic is the vacuum in the Cognition*. That TRUTH can travel with an infinite velocity through vacuum in the Cognition reveals the significant difference between the Universe and the Cognition. The second impressive consequence of the infinite vacuum velocity of TRUTH is that every BECOMING in the Cognition has infinite amount of TRUTH. This consequence might be the very reason for a verb in a natural language to have no truth value. This is because each verb does have an infinite big truth value that out the reach of any logics! Since this infinite big truth value can not be defined under any logics, it is out of the comprehension of these logics.

- 2) When $\psi = 0$, we model a cognitive medium with continuous fuzzy membership functions. In this case we get $\tau = 0$. This means that the TRUTH velocity in such a cognitive medium is zero. With a zero TRUTH velocity, a cognitive system can not finish any cognitive task within any finite time period. Of course, human cognition is not such a system. This is equivalent to say that the cognitive quantum does exist in human cognition.
- 3) Equation (13) can be used to find cognitive quantum from τ which should be easier to measure than ψ in some cognitive media like human brains.

Law 1. [Upper Limit of Truth Velocity in Cognitive Medium]. *The cognitive medium with a cognitive quantum $\psi \in [0, 1]$ has an upper limit of TRUTH travelling velocity $\tau = \sqrt{2\psi - 2\ln(1 - \psi)}$.*

Let us write ψ as a function of τ as follow

$$\psi = 1 - \Gamma_W(e^{1-\tau^2/2}) \quad (14)$$

where $\Gamma_W(\cdot)$ is the Lambert's W function[7]. It follows from Eq. (14) that the relation between the cognitive quantum and the TRUTH velocity shown in Fig. 2. Observe that the cognitive quantum approaches very close to 1 when TRUTH velocity τ approaches to 4.

The remaining problem is to set the metric system for the TRUTH velocity τ and cognitive quantum ψ . Let us rely again

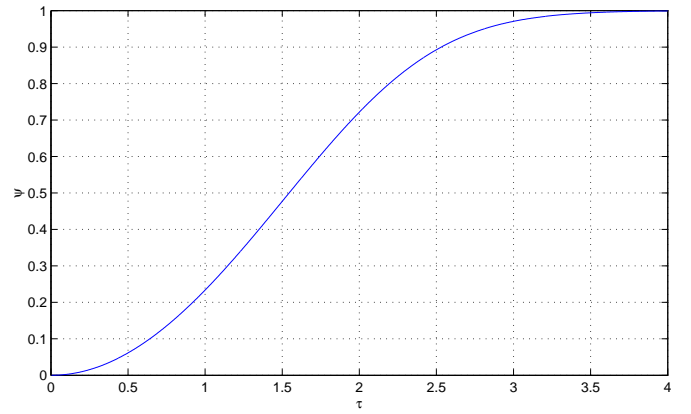


Fig. 2. Cognitive quantum as a function of TRUTH velocity in cognitive media.

on the following dualities

$$\begin{aligned} &\text{physical velocity in the Universe}[m/s] \\ &\leftrightarrow \text{TRUTH velocity in the Cognition}[t/\zeta], \\ &\text{matter in the Universe}[g] \leftrightarrow \text{BEING in the Cognition}[b], \\ &\text{energy in the Universe}[J] \\ &\leftrightarrow \text{BECOMING in the Cognition}[bt^2/\zeta^2] \end{aligned} \quad (15)$$

where $[b]$ =bit is the unit of the most abstract BEING, the information. $[t]$ =tao is the metric unit of TRUTH distance in the Cognition, $[\zeta]$ is the metric unit of time in the Cognition.

Remark. Should the time in the Universe and the time in the Cognition the same parameter? I am not very sure. Since time is only a parameter for the dynamics of the Universe and the Cognition, it might be too rash to define the time in the Cognition without knowing the dynamics of the Cognition. Therefore, although the time in the Universe is linear, I am not very sure whether the time in the Cognition is linear or not. However, I think the time in the Cognition is most likely to be linear too. The relation between $[s]$ and $[\zeta]$ needs to be determined using experimental observations.

V. TRUTH DISTANCE

To speak about velocity we must first know the distance, this is also the case when we consider the TRUTH velocity. Let us first take a look at a cognitive medium with Boolean logic. The number of steps needed to evaluate the truth value of a logic operation is defined as the TRUTH distance of the logic operation. Let TRUTH be defined in a metric space \mathbb{T} with a distance ϑ then ϑ must satisfy the following properties.

Law 2. [Properties of TRUTH Distance]

- 1) For any logic expression a , $\vartheta(a) \geq 0t$.
- 2) If a logic expression a can be split into two logic expressions b and c , then $\vartheta(a) = \vartheta(b) + \vartheta(c)$.

A. TRUTH Distance in Boolean Logic

We have the following basic TRUTH distance.

Law 3. [TRUTH Distances of Basic Logic Operations/Expressions in Boolean Logic]

- 1) *Equivalence(=)*. $\mathfrak{d}(=) = 0t$. This is because any truth will be equivalent to itself and therefore no distance is needed for self-reference.
- 2) *NOT(\neg)*. $\mathfrak{d}(\neg) = 1t$.
- 3) *AND(\wedge)*. $\mathfrak{d}(\wedge) = 1t$.
- 4) *OR(\vee)*. $\mathfrak{d}(\vee) = 1t$.
- 5) *Constant(verum) T*. $\mathfrak{d}(T) = 0t$.
- 6) *Constant(falsum) F*. $\mathfrak{d}(F) = 0t$.

Since all Boolean logic expressions are built from the basic logic operations/expressions, it follows from Laws 2 and 3 that the TRUTH distance in Boolean logic is discrete.

It follows from Laws 2 and 3 that

Theorem 1. For any logic expressions a and b , the followings are satisfied.

- 1) $\mathfrak{d}(a = b) = \mathfrak{d}(a) + \mathfrak{d}(b)$.
- 2) $\mathfrak{d}(\neg a) = 1t + \mathfrak{d}(a)$.
- 3) $\mathfrak{d}(a \wedge b) = 1t + \mathfrak{d}(a) + \mathfrak{d}(b)$.
- 4) $\mathfrak{d}(a \vee b) = 1t + \mathfrak{d}(a) + \mathfrak{d}(b)$.

Proof. The proof is straightforward by using Law 2 to split the logic expression and Law 3 to assign extra TRUTH distances.

- 1) $\mathfrak{d}(a = b) = \mathfrak{d}(a) + \mathfrak{d}(=) + \mathfrak{d}(b) = \mathfrak{d}(a) + 0t + \mathfrak{d}(b)$.
- 2) $\mathfrak{d}(\neg a) = \mathfrak{d}(\neg) + \mathfrak{d}(a) = 1t + \mathfrak{d}(a)$.
- 3) $\mathfrak{d}(a \wedge b) = \mathfrak{d}(a) + \mathfrak{d}(\wedge) + \mathfrak{d}(b) = 1t + \mathfrak{d}(a) + \mathfrak{d}(b)$.
- 4) $\mathfrak{d}(a \vee b) = \mathfrak{d}(a) + \mathfrak{d}(\vee) + \mathfrak{d}(b) = 1t + \mathfrak{d}(a) + \mathfrak{d}(b)$.

Theorem 2. Let x be a Boolean variable, the logic operations of assigning x a value of T or F have minimum TRUTH distances of $1t$.

Proof. Note that the minimum distance can only achieved by applying minimum number of basic logic expressions.

- 1) We assign a T value to x by using the logic operation $\vee T$ that has a TRUTH distance $\mathfrak{d}(\vee) + \mathfrak{d}(T) = 1t$.
- 2) We assign a F value to x by using the logic operation $\wedge F$ that has a TRUTH distance $\mathfrak{d}(\wedge) + \mathfrak{d}(F) = 1t$.

Theorem 3. [Maximum Logic Operating Speed in a Cognitive Medium] Given a cognitive medium with a cognitive quantum $\psi \in [0, 1]$, the maximum number of a specific logic operation, of which the TRUTH distance is $d[\text{tao}]$, can be performed in a unit time is τ/d .

Proof. It follows from Law 1 that the maximum TRUTH distance that the cognitive medium with a cognitive quantum ψ can cover in a unit time is $\tau[\text{tao}]$, the maximum number of logic operations of TRUTH distance d is τ/d .

It follows from Theorem 3 that a computer built on Boolean logic operations can achieve unlimited computational power for calculating Boolean logic expressions. Of course, this is not to say this computer has unlimited computational powers to implement other logic systems, say, fuzzy logic. We then have the following conclusion.

Lemma 1. A cognitive medium with Boolean logic can have unlimited computational power for implementing Boolean logic operations.

The conclusion in Lemma 1 guarantees that we can always build a more powerful computer based on Boolean logic no matter how fast the computers we have today. This is the reason why Boolean logic based digital computers can improve their speed toward any physical limit. In the design of a

Boolean logic based computer, the physical limit is the only limit for its computing speed.

B. TRUTH Distance in Multivalued Logics

Let us consider Gödel logic where the logical matrix is a finite set

$$W_m = \left\{ \frac{k}{m-1} \mid 0 \leq k \leq m-1 \right\}, m > 2. \quad (16)$$

of rationals within the real unit interval. The degree 1 is the only designated truth degree. Two connectives of this logic system are a conjunction and a disjunction given by the following truth degree functions

$$x \wedge y = \min\{x, y\}, x \vee y = \max\{x, y\}, \quad (17)$$

a negation connective \neg and an implication connective \rightarrow with truth degree functions

	$\neg u$		$x \rightarrow y$
$x = 0$	1	$x \leq y$	1
$x \neq 0$	0	$x > y$	y

(18)

Law 4. [TRUTH Distances of Basic Logic Operations/Expressions in Gödel logic]

- 1) *Equivalence(=)*. $\mathfrak{d}(=) = 0t$.
- 2) *NOT(\neg)*. $\mathfrak{d}(\neg) = 1t$. Note that this logic operation is implemented in the same way as that in Boolean logic.
- 3) *AND(\wedge)*. $\mathfrak{d}(\wedge) = 1t$.
- 4) *OR(\vee)*. $\mathfrak{d}(\vee) = 1t$.
- 5) *Constant(verum) T*. $\mathfrak{d}(T) = 0t$. Since degree 1 is the only designated truth degree, a T must be 1. Therefore, T is always self-referenced.
- 6) *Constant(falsum) F*. $\mathfrak{d}(F) = (m-2)t$. Since degrees 0 to $\frac{m-2}{m-1}$ are not truth degree, there are $(m-2)$ possible non-self-referenced choices. Note that when $m = 2$, this conclusion is consistent to that for Boolean logic.

Since $\psi = \frac{1}{m}$ in Gödel logic, a computer based on Gödel logic will have a limited maximum TRUTH velocity. Therefore, if Gödel logics can be implemented in a Boolean-logic based computer, it is not necessary to build a computer based on Gödel logic itself. We can predict that if we build a Gödel logics based computer, we will first meet the upper limit of its TRUTH velocity before we meet the physical limit for implementing Gödel logics. This leads to the following important Lemma for computer industry.

Lemma 2. Any multivalued logic based computer is slower than the same multivalued logic simulated on some Boolean logic based computers.

Lemma 2 provides us with an interesting conclusion which is conclude that try to build any computers based on multivalued logics is not practical to compete with Boolean logic based computers.

VI. VACUUM AND MEDIUM VELOCITIES OF TRUTH

The Cognition, just like the Universe, it's universal and its rules control every aspect of cognitive systems. A cognitive system is a medium for TRUTH with a given constant ψ , the cognitive quantum. We know when a light ray enters from

one medium to a different medium, the velocity of the light can change. The duality of this phenomenon is of course the change of TRUTH velocity when TRUTH enters one cognitive medium from the other. Since different cognitive media use different logics, the differences of TRUTH velocity can be predicted. The vacuum velocity of TRUTH is that in a Boolean logic systems without physical limit.

A. Reflection and Refraction

Each time a ray of light strikes a boundary between two materials some of the light is reflected. The amount of reflected light at the interface depends on the differences in refraction between the two adjoining materials. The duality of reflection of light in the Universe is the *reflection of TRUTH* in the Cognition. This means that when TRUTH travelling through the interface of two different cognitive media, there will be a possibility of losing TRUTH along the travelling path.

In physical world, the refraction is an effect that occurs when a light wave, incident at an angle away from the normal, passes a boundary from one medium into another in which there is a change in velocity of the light. The dual phenomenon in the Cognition is called the *refraction of TRUTH*(RT). When the TRUTH leaves a cognitive medium with a larger TRUTH velocity and enters a cognitive medium with a smaller TRUTH velocity, part of TRUTH will be reflected back. On the other hand, when the TRUTH leaves a cognitive medium with a smaller TRUTH velocity and enter a cognitive medium with a larger TRUTH velocity, it is possible to choose conditions under which all TRUTH can go through the interface.

Example 1. Since TRUTH travel slower in human brains than today's digital computers, it is difficult for a human brain to comprehend all the information generated by digital computers. This phenomenon is called information explosion. However, given the right conditions, computers can painlessly to store all kinds of data generated by the human society.

B. Total Internal Reflection

If light is inside a material with a larger refractive index n_2 than the refractive index n_1 of the material outside, there is an angle, the *critical angle of incidence*, beyond which the light is reflected back into the material. This is *total internal reflection*. The critical angle i_c is given by

$$\sin(i_c) = \frac{n_1}{n_2}. \quad (19)$$

The duality to the total internal reflection of light when it leaves a medium with low light velocity into a medium with high light velocity is the *total internal reflection of TRUTH*(TIRT). TIRT only happens when a TRUTH ray travels from a cognitive medium with a smaller cognitive quantum ψ_1 towards another cognitive medium with a larger cognitive quantum ψ_2 . Although at this point, the duality of the *critical angle of incidence* of light is not clear to me, it is reasonable to assume under some conditions that the TIRT can happen and the result is that all TRUTH will be retained in the cognitive medium with small cognitive quantum.

Example 2. We already know that a digital computer has a cognitive quantum bigger than that for a human brain. Under

suitable conditions the TRUTH travelling from a human brain towards a digital computer can suffer from TIRT. One of such condition is that the human brain keeps sending truth values less than the cognitive quantum of the digital computer, then all truth values can not be received by the digital computer. Under this condition, all truth will be kept by the human brain itself.

C. Mathematics of TRUTH Reflection and Refraction

In this section the mathematics of the reflection and refraction of TRUTH will be mathematically analyzed. First, let us study the structure of a TRUTH ray that is dual to a light ray in the Universe. In the physical Universe, energy can be transferred in two ways; namely, either transferred in the form of particles or in the form of waves. Since a particle is discrete and finite in space, it must be at a specific location at any moment. A particle can never exist in more than one place at once, it can not travel to two different places in space at the same moment. The motion of particles obeys the laws of kinematics, acceleration, velocity and so forth. The interactions between particles must obey the laws of the conservation of energy and momentum. On the other hand, waves cannot be considered a finite entity in the space. Their energy is not constrained at a single place. For example, light is a deformation of electric and magnetic fields in a space range along time. It is well known that light has the wave-particle duality, by using the Universe-Cognition duality we know there must be a TRUTH-information duality in a TRUTH ray. To implement a TRUTH-information duality in a cognitive medium, this medium must have the ability to transfer a mass of information into a corresponding size of TRUTH. Meanwhile, in this cognitive medium a TRUTH of BECOMING can collapse into a corresponding amount information.

If follows from Eqs. (8) and (12) that the entire TRUTH after a BECOMING collapsed is given by

$$\begin{aligned} Q &\triangleq \text{TRUTH of BECOMING} \\ &= -\ln(1-\psi) + e^{\ln(1-\psi)} - 1 \\ &= -\ln(1-\psi) - \psi \end{aligned} \quad (20)$$

where $\psi \in [0, 1]$ is the cognitive quantum of the cognitive medium. Observe that Q is the entire TRUTH when the BECOMING collapses into a mass of information. The partial TRUTH of BECOMING at the time moment before the collapse of the BECOMING is given by

$$q(t) \triangleq \int_0^t (1 - e^{-t}) dt = t + e^{-t} - 1 \quad (21)$$

where $t \in [0, -\ln(1-\psi))$. Assume that we only investigate the TRUTH ray along a very small TRUTH distance, then the dissipations of TRUTH is negligible. Figure 3 shows the TRUTH ray in a cognitive medium. Observe that as soon as the BECOMING collapses, the cognitive medium transfers a BEING into a BECOMING such that the wave of the TRUTH ray can propagate through the cognitive medium. We assume that the TRUTH distance that the TRUTH travels between two moments of collapses is the unit truth distance in this cognitive medium. The waveform between two consecutive

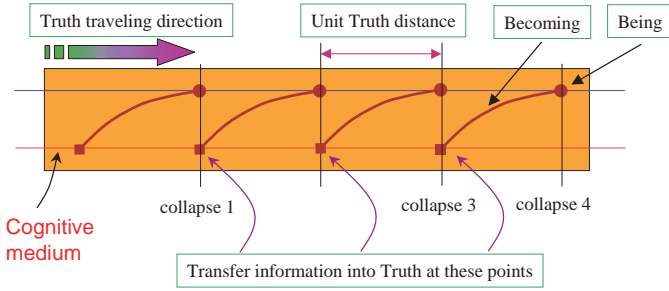


Fig. 3. A TRUTH ray, which is the duality of a light ray, travels through a cognitive medium.

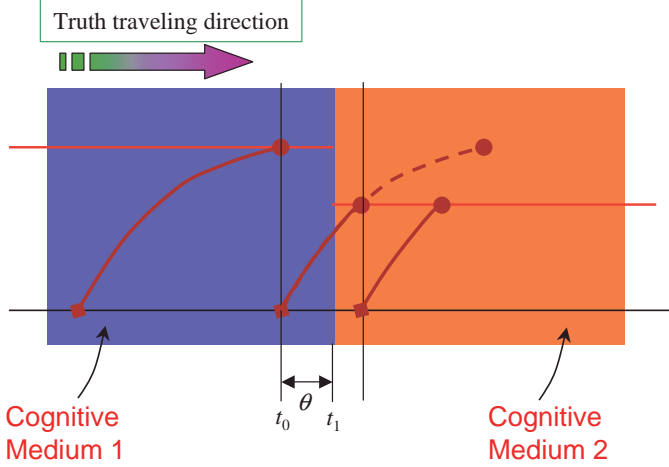


Fig. 4. A TRUTH ray travelling through the interface between two cognitive media.

collapses is the outer function of the BECOMING while at each collapsing moment a BEING emerges. We assume the BEING is transferred into BECOMING as soon as it emerges. In Section VII the mechanism of transferring a BEING into a BECOMING will be addressed.

As depicted in Fig. 4, let us assume that a TRUTH ray travels from cognitive medium 1 with cognitive quantum ψ_1 to cognitive medium 2 with cognitive quantum ψ_2 and we assume that $\psi_1 < \psi_2$. Since in the cognition medium 2 the TRUTH velocity is higher than that in the cognition medium 1, the original outer function of BECOMING will be shortened as soon as the TRUTH travelling into the cognition medium 2. In the case shown in Fig. 4, at the interface, the outer function of BECOMING is not reach the collapsing point of that for the cognition medium 2. In this case, the BECOMING will continue to grows in the cognition medium 2 and finally reach the collapsing point in the cognition medium 2. In this case, the entire TRUTH in the TRUTH enters the cognition medium 2 without reflection, we call this situation the *total throughput*(of TRUTH).

In order to quantitatively inspect the total throughput, we first define the phase of incidence of the incident TRUTH ray as follows.

Definition 2. [Phase of Incidence] *Let us assume that the incidence TRUTH ray is leaving the cognition medium 1 and entering the cognition medium 2. Let ψ_1 be the cognitive quantum of the cognition medium 1, t_0 be the moment when*

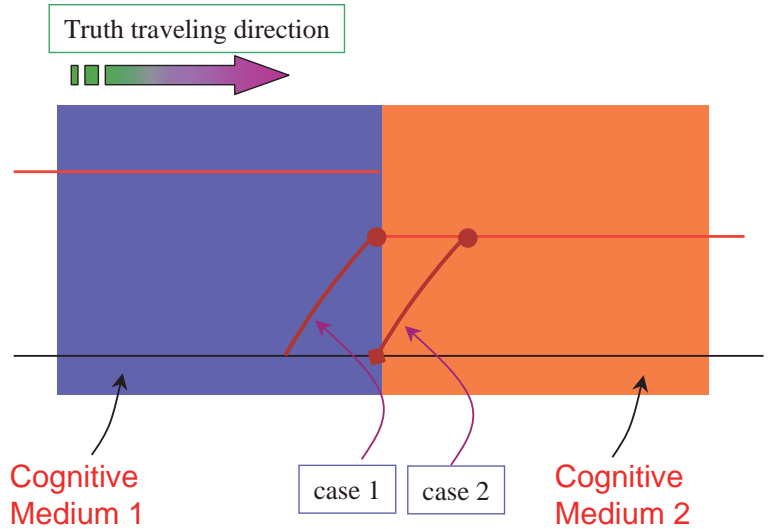


Fig. 5. Range of the phase of incidence for the total throughput of the TRUTH.

the latest collapse in the cognition medium 1 happens and t_1 be the moment when the incidence TRUTH ray arrives at the interface, then $t_1 - t_0$ is called the phase of incidence denoted by θ .

The definition of phase of incidence θ is depicted in Fig. 4. We have the following theorem to quantitatively provide the range of the phase of incidence for total throughput.

Theorem 3. [Total Throughput of TRUTH] *Let us assume that the incidence TRUTH ray is leaving the cognition medium 1 and entering the cognition medium 2. Let ψ_1 and ψ_2 be the cognitive quanta of the cognition medium 1 and 2, respectively, then the condition of the total throughput of the TRUTH ray is that*

$$\theta \in (0, -\ln(1 - \psi_2)), \text{ given } \psi_1 < \psi_2 \quad (22)$$

where θ is the phase of incidence.

Proof. As shown in Fig. 5 that the range of the phase of incidence for the total throughput is bounded by the outer functions of case 1 and case 2. In the case 2, $\theta = 0$ is satisfied. In the case 1, θ is given by the life span of the BECOMING in the cognition medium 2, therefore the upper range of θ is $-\ln(1 - \psi_2)$.

Let us take a look at the cases depicted in Fig. 6 where the BECOMING grows to a value that is bigger than the cognitive quantum ceiling for the cognition medium 2 if the phase of incidence is between case 0 and case 1. Therefore, as long at the outer function crosses the interface, it immediately collapses in the cognition medium 2 with a partial of TRUTH reflected back to the cognition medium 1. The range of the phase of incidence is bounded by case 0 and case 1.

Theorem 4. [Coexistence of Refraction and Reflection of TRUTH] *Let us assume that the incidence TRUTH ray is leaving the cognition medium 1 and entering the cognition medium 2. Let ψ_1 and ψ_2 be the cognitive quantum of the cognition medium 1 and 2, respectively, then the condition of the coexistence of the refraction and reflection of the TRUTH*

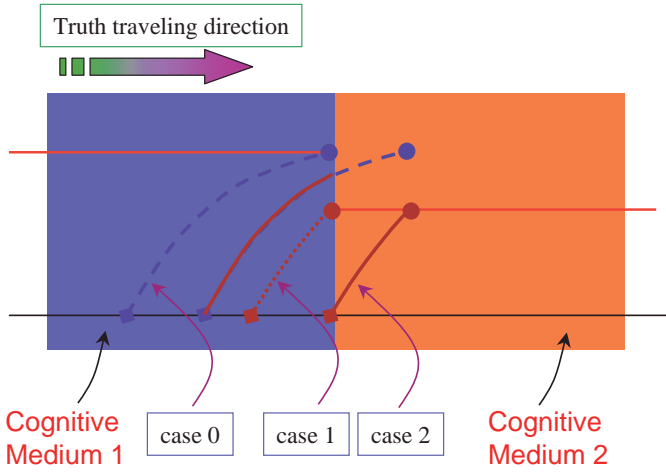


Fig. 6. Range of the phase of incidence for the coexistence of refraction and reflection of the TRUTH.

is given by

$$\theta \in (-\ln(1 - \psi_2), -\ln(1 - \psi_1)), \text{ given } \psi_1 < \psi_2 \quad (23)$$

where θ is the phase of incidence.

It follows from Eq. (21) that the reflected portion of TRUTH is given by

$$q(t) = (\theta + e^{-\theta} - 1) - (-\ln(1 - \psi_2) - \psi_2) \quad (24)$$

where $\theta \in (-\ln(1 - \psi_2), -\ln(1 - \psi_1))$.

The total internal reflection of TRUTH happens when $\theta = -\ln(1 - \psi_1)$.

One should note that the TRUTH must be conserved at the interface. Since it is very possible that the BECOMING in the cognitive medium 1 contains more TRUTH than the maximum TRUTH size of a single BECOMING in the cognitive medium 2, at the interface the BECOMING in the cognitive medium 1 might split into more than one BECOMING in the cognitive medium 2. However, even this is the case, the TRUTH must be conserved at the interface.

So far, we only consider the case when a TRUTH ray travels from a cognitive medium with low cognitive quantum to a cognitive medium with a high cognitive quantum. This is the dual situation of light travelling from water to air. Let us then consider the case when a TRUTH ray travels from a cognitive medium with a high cognitive quantum to a cognitive medium with a low cognitive quantum as duplicated in Fig. 7. Let us assume that the maximum amount of TRUTH for any BECOMING in the cognitive medium 1 can not make a BECOMING in the cognitive medium 2 to collapse, the TRUTH can not leave the interface in the cognitive medium 2 until enough TRUTH is accumulated at the interface.

This process is depicted in Fig. 8. In Fig. 8(a) we show that the 0-th BECOMING is entering into the cognitive medium 2 while the 1st and the 2nd BECOMINGS are travelling in the cognitive medium 1. In Fig. 8(b) we show that the 0-th BECOMING is travelling in cognitive medium 2 while the 1st BECOMING is entering cognitive medium 2. At this moment, the first BECOMING in the cognitive medium 2 can not collapse because the amount of TRUTH in the 0-th

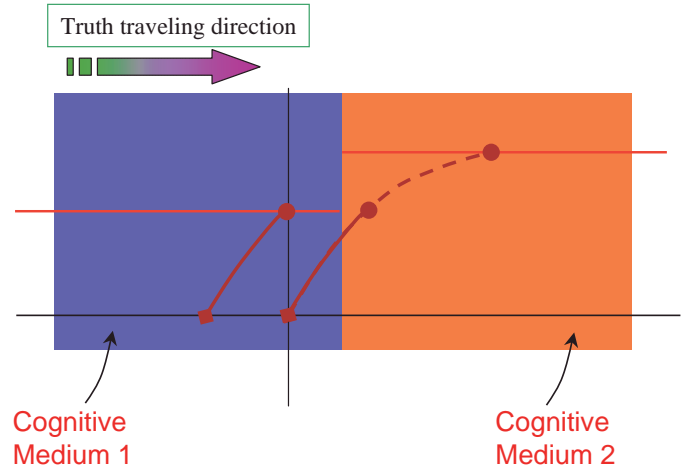


Fig. 7. A TRUTH ray travelling through the interface between two cognitive media.

BECOMING is not enough. Assume that the sum of the amount of TRUTH in both the 0-th and the 1st BECOMINGS can trigger the first BECOMING in cognitive medium 2 to collapse, then we have the scenario shown in Fig. 8(c). At this moment, the first BECOMING in cognitive medium 2 collapses and the second BECOMING emerges caused by the TRUTH injected by the 2nd BECOMING in cognitive medium 1. Therefore, the TRUTH velocity in cognitive medium 2 must be slower than that in cognitive medium 1. The reflection can occur when the sum of amount of TRUTH in the 0-th and the 1st BECOMINGS are bigger than the first BECOMING in cognitive medium 2.

VII. BEINGS AND ANTI BEINGS

The duality between the Cognition and the Universe implies the duality between *mentalism* and *materialism*. For each BEING in materialism, there is an AntiBEING in mentalism. As already known by physicists, the only way for all energy in a matter to be released is for the matter to be totally *annihilated*. An annihilation involves the complete destruction of matter, and occurs only when that matter meets an equal amount of antimatter. By using the Universe-Cognition duality, for all TRUTH in a BEING to be released is for the BEING to be totally *annihilated* when the BEING meets an equal amount of AntiBEING. Since the metric unit for a BEING is a [b]it, the TRUTH of a bit of BEING in the Universe can only be fully released when it meets a negative bit of BEING in the Cognition. From this point of view all logic systems can be categorized into two categories.

- 1) *Annihilated Logics*. In this kind of logic, each BEING in the Universe is annihilated by the same amount of AntiBEING in the Cognition. As a result, in this kind of logic, the Universe plays no role. In other words, this kind of logic is (*physical*) *context free*. In this kind of logic, TRUTH is pure.
- 2) *Non-annihilated Logics*. In this kind of logic, the annihilation can not happen. Therefore, a BEING has no chance to release its full TRUTH. However, some processes, which are dual to *nuclear fusion* and *nuclear fission*, can release partial of the full TRUTH from the BEING.

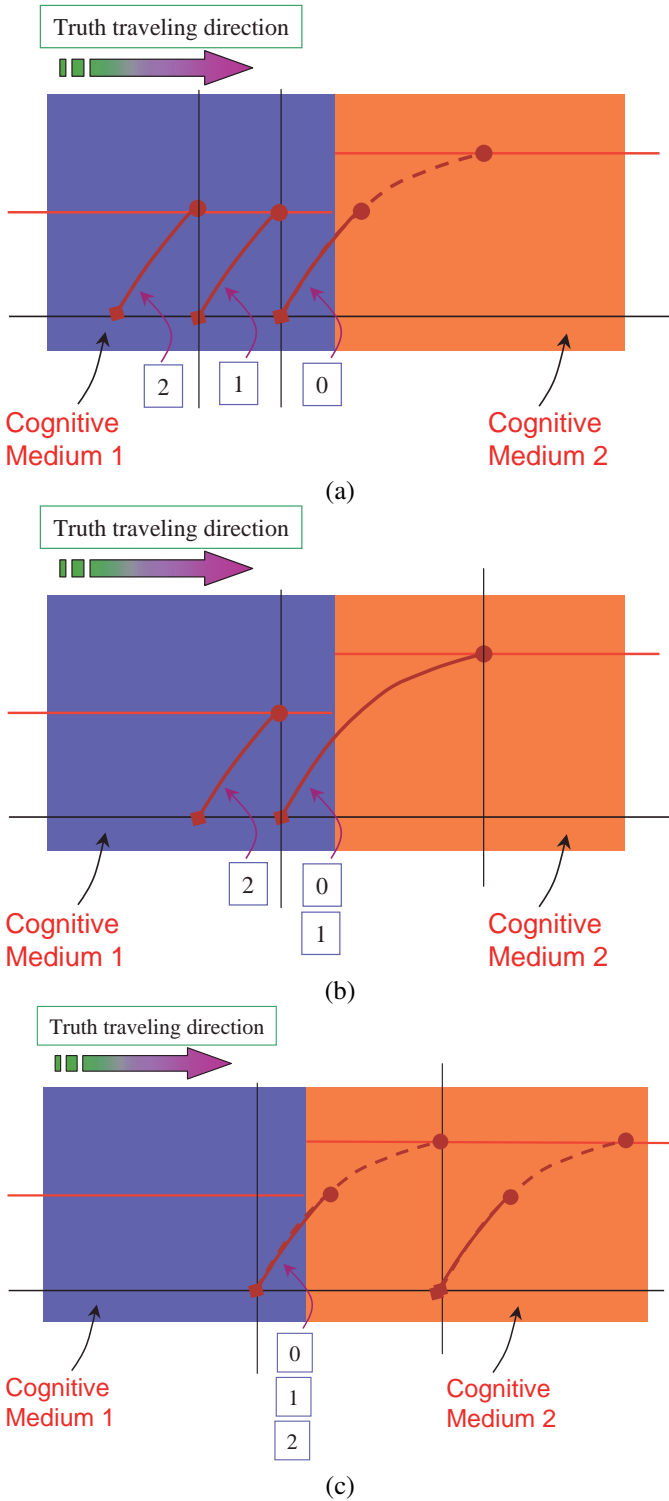


Fig. 8. A TRUTH ray travelling through the interface between two cognitive media. (a) At moment 1. (b) At moment 2. (c) At moment 3.

Any non-annihilated logic faces a world without “pure TRUTH”. In other words, any thing in that world can not be 100% for sure. I think this kind of world is dual to physical quantum world.

The hybrid forms of annihilated logics and non-annihilated logics are called *hybrid logics*. Some well-known examples of hybrid logics are fuzzy logic, intuitive logic and multivalued logics.

Since a logic system functions as a cognitive medium in the Cognition, it is worth to discuss the role that a logic system plays in the Universe. As a cognitive medium, a logic system can host the travelling of TRUTH. Let us assume a Universe without any logic systems, then the TRUTH has nowhere to travel. In other words, in a Universe without any logics, TRUTH is trapped in the Cognition and invisible to that Universe. This might be the reason that animals without logic systems; namely, the language systems, can not reveal the TRUTH from the Cognition. Also, as cognitive media, logic systems play the critical role to release the TRUTH from physical BEINGS. Without a logic system serving as the cognitive medium, the AntiBEINGS from the Cognition has noway to meet physical BEINGS in the Universe. The context-free logics are cognitive media where each physical BEING can be guaranteed to meet its cognitive AntiBEINGS.

Let us answer Einstein’s question: “How can it be that mathematics, being after all a product of human thought independent of experience, is so admirably adapted to the objects of reality?” First, Einstein had a very deep insight to the context-free property of mathematics when he realized mathematics is “independent of experience”. This context-free property of mathematics is stemmed from the fact that mathematics is constructed from annihilated logics. Second, being a physicist, “the objects of reality” in Einstein’s mind was of course the physical world. By using the duality, Einstein’s question can be translated into a doubt to the following equation

$$\text{mathematical TRUTH} \leftrightarrow \text{physical BEING} \quad (25)$$

where \leftrightarrow denotes Einstein’s “admirably adapted to”. Although I don’t know what the exact meaning of “admirably adapted to” in Einstein’s mind, I will treat \leftrightarrow as a one-to-many association. From this point of view, for each mathematical TRUTH, there is *at least one* physical BEING to associate with if Eq. (25) holds.

Equation (25) does hold because of the following *cognitive reaction*

$$\begin{aligned} &\text{mathematical TRUTH} \\ &\Leftrightarrow \text{mental antiBEING} + \text{physical BEING}. \end{aligned} \quad (26)$$

Since the right side of this equation is an annihilation between a BEING and its AntiBEING, mathematical TRUTH must form an annihilated logic. This answers Einstein’s question by associating each mathematical TRUTH to at least one physical BEING. From the reverse direction, different kinds of physical BEING can associate with the same mathematical TRUTH. It is based on Eq. (3) that

$$\text{mathematical TRUTH} = \text{physical BEING} \times \tau^2 \quad (27)$$

TABLE I
THE DUAL PAIRS FROM DIFFERENT LEVEL OF DOMAINS

Domains	Yin	Yang
Abstract level	information	truth
Metric unit	[bit]	$[\text{bit}] \times [\text{tao}]^2 / \zeta^2$
Logic framework	physical BEING	mathematical TRUTH
Physics	matter	energy
Dialectics	relatives	the only constant
Cognitive framework	BEING	BECOMING

where τ is the vacuum TRUTH velocity of the Cognition.

Since different terminologies are used in different domains for BEING and BECOMING, we list all of them in Table I for comparison. Observe that all these Yin-Yang pairs can be unified by the Universe-Cognition(Unicogse) framework.

VIII. ELEMENTS AND ELEMENTARY PARTICLES OF BEINGS

Experts in linguistics tried to set up lexical hierarchies for all kinds of words. However, verbs, adjective, and adverbs don't fit into hierarchical structures very well. Linguistic experts found that only nouns fit a lexical hierarchy well though they can not provide a good explanation for this. However, this fact is self-evident if we recall that nouns are the only BEINGS in natural languages. Thinking about physics, matters, which are dual to BEINGS, can have clear hierarchical structures either from the point of view of scales or chemical properties. As we already know, in physics the matters are organized into a hierarchy based on element particles while in chemistry the matters are organized into a hierarchy called periodic table.

We first study the hierarchy of BEINGS based on the duality to elementary particles. The category of elementary particles of BEINGS are based on the bit mass. We assume that the most basic particles have a one-bit mass. In WordNet there are 11 unique beginners for nouns: entity, abstraction, psychological feature, natural phenomenon, activity, event, group, location, possession, shape and state. Obviously, not all of these unique beginners are of a one-bit mass as shown in Table II.

In physical linguistics, nouns can also be organized into a periodic table based hierarchy to reflect the fact that the properties and attributes of nouns play important roles in linguistics. The unique beginners proposed in WordNet might be candidates for elements of BEINGS in physical linguistics. However, we can not follow WordNet to organize the elementary BEING periodic table because it is mainly from the English viewpoint of human languages. At least in Chinese, the nouns are organized in the way more likely from different point of view. After setting up the hierarchy of BEINGS it will be easy to build physical linguistics from both the physical and chemical directions.

IX. FUSION AND FISSION OF BEINGS

In physical *nuclear fusion*, when two protons collide to each other with very high speed, they can combine and release energy. Therefore, two combined protons have less mass than two separate protons. By using the Universe-Cognition duality, two simple BEINGS can be combined into a composed BEING with less mass. The duality of the high speed to collide two

protons towards each other is the collective strong belief of the TRUTH that makes the composed BEING a word. The process of fusion in physical linguistics is as follows.

- 1) Two nouns N_1 and N_2 are collided to each other and release a BEING of mass m , the result is a composite noun N_3 ; namely

$$N_1 + N_2 = N_3 + \text{BEING}_m. \tag{28}$$

The mass in the sense of BEINGS is balanced in both sides of this equation.

- 2) In the Cognition, BEING_m is annihilated by an Anti BEING_m and a TRUTH_m is generated

$$\text{TRUTH}_m = \text{BEING}_m \times \tau^2. \tag{29}$$

- 3) Thinking about the process of how a new noun is generated from two old nouns we can understand how in the Cognition N_3 can be treated as being "true". We need enough percentage of the population to cognitively accept N_3 as a valid noun. Assume statistically each individual can contribute TRUTH_m towards N_3 , then the collection of n individuals who cognitively treat N_3 as a noun contribute an $n\text{TRUTH}_m$ to the truth value of N_3 being a noun.
- 4) Only when $n\text{TRUTH}_m$ is bigger than a threshold then N_3 can be a valid noun in the Cognition. $n\text{TRUTH}_m$ is the total amount of TRUTH that we collide N_1 and N_2 toward each other. By using the Universe-Cognition duality, $n\text{TRUTH}_m$ is dual to the energy that we need to bring two groups of protons to each other in the Universe.

Example 3. Let us take a look at the following equation

$$\begin{aligned} \text{火} + \text{箭} &= \text{火箭} \\ \text{Fire} + \text{Arrow} &= \text{Rocket} \end{aligned} \tag{30}$$

This is the fusion equation of Chinese noun 火箭 (rocket). On the left side, two Chinese nouns 火 (fire) and 箭 (arrow) are collided to give a combined Chinese noun 火箭 (rocket) on the right side. Equation (30) tells us many principles of mass of BEING and TRUTH.

- 1) First, although the mass of BEING has a metric unit of [bit] which is the same metric unit of information, the mass of a noun is not the same as the information of the noun. It follows from Eq. (28) that the sum of information in 火 (fire) and 箭 (arrow) must be greater than that in 火箭 (rocket). However, from the computer science point of view, it will take the same amount of bits to code " 火 (fire) + 箭 (arrow)" and " 火箭 (rocket)" in an encoding scheme for Chinese. Therefore, this example shows us that the mass of cognitive BEINGS is different from the informatics codings of nouns. This of course causes us some troubles to measure the cognitive mass of each nouns in physical linguistics. However, the task of measuring the mass of each noun in physical linguistics is entirely achievable.
- 2) Physical linguistics is language-independent. Although in English we don't call rocket as fire-arrow, it doesn't

TABLE II
THE MASS OF UNIQUE BEGINNERS OF NOUNS PROPOSED IN WORDNET.

unique beginners mass(bit)	entity 1	abstraction 1	psychological feature > 1	natural phenomenon > 1
unique beginners mass(bit)	activity > 1	event > 1	group > 1	location 1
unique beginners mass(bit)	possession > 1	shape > 1	state > 1	

means that in the Cognition we can't have Eq. (30). The reason that in Chinese Eq. (30) is valid is that in the Cognition, many Chinese individuals cognitively contribute their TRUTH_m to “火箭(rocket)”.

In physics, there is another process called nuclear fission where mass is transformed into energy. This is because elements heavier than iron are unstable. A heavy nuclei is composed of many positively charged protons that repel from each other. In some elements, such as uranium, nuclei fall apart because the repelling force amount protons. When this happens, the resulting new elements are less massive in total than the original uranium atoms. Energy is released during nuclear fission. By using the Universe-Cognition duality, we can conclude that if a noun in physical linguistics is composed by many other nouns from a fusion process, then it becomes unstable if the number of nouns composing it becomes too big. This might be a reason that though in theory we can construct a Chinese noun as long as possible, in real life, we rarely find a noun more than 10 Chinese characters. Let us take a look at the following example.

Example 4.

$$\begin{aligned}
 & \text{无产者} + \text{阶级} + \text{文化} + \text{大革命} = \text{无产阶级文化大革命} \\
 & \hspace{10em} = \text{文化大革命} \\
 & \hspace{10em} = \text{文革} \\
 & \text{Proletarian} + \text{Class} + \text{Culture} + \text{big Revolution} = \text{Cultural Revolution}
 \end{aligned}
 \tag{31}$$

The first line of Eq. (31) is the fusion process of four Chinese nouns 无产者(proletarian), 阶级(class), 文化(culture) and 大革命(big revolution). The result of the fusion process is 无产阶级文化大革命(cultural revolution) which consists of nine Chinese characters. However, 无产阶级文化大革命(cultural revolution) is unstable and during the evolution of Chinese, a fission process first leads to a new noun 文化大革命(cultural revolution) which consists of only five Chinese characters. The fission processes can keep going on until a stable Chinese noun 文革(cultural revolution), which consists of only two Chinese characters, appears. History proved that 文革(cultural revolution) is entirely stable and no fission can occur anymore. In fact, in Chinese the nouns of two or three characters are the most stable ones. Nouns of one Chinese character are usually play important role in fusion processes. Nouns of more than four Chinese characters are rarely stable. Of course, unstable is not the only condition to trigger a fission.

We can write the fission equation for nouns as follow.

$$N = \sum_{i=1}^n N_i + \text{BEING}_m \tag{32}$$

where N is the noun subjected to the fission process while N_i, i = 1, ..., n, are nouns of the fission results. BEING_m is a BEING with mass m. Note that the BEING_ms in both Eqs. (28) and (32) are not necessarily the same. The BEING_m in Eq. (32) can be transformed into a TRUTH by using the same annihilating process in a noun fusion.

Remark. Since the TRUTH in the Cognition must be conserved. This means that for any fusion and fission of nouns to happen, there must be TRUTH sinks to absorb the extra TRUTH generated. In the Cognition, these kinds of TRUTH sinks are human brains. How can we measure BEING_ms in Eqs. (28) and (32)? It will be difficult to measure BEING_ms directly because it is not a physical entity. However, we can measure the TRUTH_m in Eq. (29) by measuring the statistical belief of a noun to be a valid one among a big enough population.

X. THE BIG BANG THEORY OF THE COGNITION

Fusion and fission of BEINGS are two processes where mass of BEINGS are transformed into TRUTH with the help of AntiBEINGS in the Cognition. Should there be some kind of process that TRUTH can be transformed into BEINGS? The answer is YES. And the answer is closely connected to the dual problem: the origin of the Universe.

We certainly know that our universe exists, do we? The Universe and the Cognition is not only a dual pair, but also a mutually indispensable pair of the Unicogse. I can not imagine a cognition without a universe, either a universe without a cognition. The beginning of the Universe is also the beginning of the Cognition. Let us recall some details of the Big Bang theory of the Universe before we can apply the duality to the Big Bang theory of the Cognition.

About 15 billion years ago a tremendous explosion, which is known as the Big Bang, started the expansion of the Universe. At the very moment of the Big Bang, all of the matter and energy of space was contained at one point. The Big Bang is an explosion of space within itself and filling all of space with all of the particles of the embryonic universe rushing away from each other. In the very beginning there was nothing except for a plasma soup. Then when the temperature cooled down, at around 10⁻⁴³ seconds after creation, there existed an almost equal yet asymmetrical amount of matter and antimatter. As these two materials are created together, they collide and destroy one another creating pure energy. Since the asymmetry of about one part per billion in favor of matter, matter becomes

dominate while the universe kept expanding. Then we have a quark soup when baryons formed. Those baryons are photons, neutrinos, electrons and quarks that are the building blocks of matter. Afterwards, when the Universe had cooled to about 3000 billion degrees Kelvin, hadrons such as protons and neutrons appeared. About one to three minutes later, protons and neutrons began to react with each other to form deuterium. Then tritium and helium nucleus appeared soon after.

What did happen in the Cognition when the Big Bang happened in the Universe? The Cognition underwent the dual Big Bang along the same time line. When the Universe was still a plasma soup, the Cognition is a TRUTH soup, there was no BEINGS at that moment except for BECOMINGS. All the BECOMINGS at that moment have almost homogenous probabilities of becoming any BEINGS that would merge. When the Universe cooled down to a quark soup, the most basic BEINGS condensed from the TRUTH soup. At this stage, some BECOMINGS collapse into BEINGS. Since at the moment the TRUTH quantum was just formed and was equal to the only truth value at that moment in the Cognition, the TRUTH velocity is infinite everywhere. This means that the TRUTH status was homogenous everywhere in the embryonic Cognition such that if one statement was true at one place it was true anywhere without time delay. As the Universe kept cooling down, the TRUTH velocity decreased at some places. The more complex the Universe became, the slower the TRUTH velocity became at some places.

The Big Bang theory of the Cognition tells us some amazing stories that might be against the very existing theory of cognition.

- 1) First, cognition had been existed since the very beginning of the Universe.
- 2) Second, cognition is human brain independent.
- 3) Third, the human brain is only one possible structure that can develop high-level cognition. It is very possible that other kinds of physical systems can develop cognitions. And no matter how different the structures of these systems might be comparing with human brains, the cognitions in those systems controlled by the same laws in the Cognition. On the other hand, for two different cognitive species, the communication will be no problem as long as the encoding schemes are constructed based on laws in the Cognition. The communication between two intelligent species based on physical laws has less chance to success than that based on laws in the Cognition.

XI. CONCLUDING REMARKS

Why TRUTH needs sizes? For computer scientists or for any logicians, it will be nonsense to assign a measurement to truth. From conventional point of view, a statement might have a “degree of truth” or a “truth value”, however, it sounds funny to say: “My truth is as twice as bigger as yours.” Of course, it is entirely comfortable to say “My *degree of truth* is as twice as bigger as yours”. Therefore, the *degree of truth* and truth itself are different. In a context-free settings, just as those in most logics, truth is independent of cognition and therefore

every truth is equal, no matter it is represented by Boolean logic or by the fuzzy logic. For example, in both Boolean and fuzzy logics, the truth is represented by 1.

However, in the Cognition, this is not the case anymore. Some truths are bigger than others in the Cognition. For example, the truth of “computer is on” is bigger than the truth of “software is ok” because if the “computer is on” is not a truth, then we don’t need to care about the truth of “software is ok”. This example shows that in the Cognition, the TRUTH is not context-free. Therefore, it needs to assign a way to distinguish their quantitative differences imposed by their contexts.

The most useful results of making TRUTH in the Cognition measurable are listed as follows.

- 1) Building a new generation of computers with measurable TRUTH such that different events can be processed based on a TRUTH hierarchy. In these new computers, attentions and meanings are weighted by the sizes of TRUTH.
- 2) Human brains are not the only ones to have cognition, to have meanings, to have feelings, etc. It is possible for a human-made system to have these cognitive properties. This is because the Cognition is independent of physical platforms. Human brains merely function as interfaces between the Cognition and the Universe.
- 3) The best way to setup the system of metrics of the Cognition is to measure the TRUTH velocity in a human brain. The constant τ in a human brain should be the average speed of neural transmitting speed. For example, we can measure the responding time between looking at a visual stimulation and speaking out its name. However, the time period containing three components. The first component is the input time for sending the visual stimulate back to the brain. The second one is the truth travelling time between visual truth to language truth. The third one is the output time for speaking out the words. Only the second time component can be taken as the travelling time of the TRUTH. The challenges to experiments of measuring the TRUTH velocity will be the separation of these time periods.
- 4) After measuring the TRUTH velocity in human brains, the quantum ψ of human brains can be calculated.

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