ABSTRACT
With the recent advancements in the area of artificial intelligence and robotics, there is much discussion about how far the technology will advance and whether AI might even surpass the general capacity of humans in both mental and physical ability, a hypothesis known as technological singularity. The similarities and differences between machines and humans based on the science of computation and philosophy are addressed. Indeed, starting from investigating physics problems, one is led to adopt a new perspective on the machine and human consciousness based on cyclical time. In particular, this model involves not only a physical system, as has often been the case in science, but also mental aspects as a fundamental and integral part of a complete picture. Unlike science, philosophy has been investigating both physical and mental states and characteristics since the era of the ancient Greeks, and it has been posited that the new model of existence derived from physics and comparing machine and human indeed bears a resemblance to a number of philosophical thoughts, particularly from the school of existentialism.

Key Words: Artificial Intelligence, Consciousness, Philosophy, Quantum Theory

Introduction
With the tremendous growth in computing power, the significant increase in the amount of data, and the development of deep learning in the area of artificial intelligence (AI), we have recently witnessed great progress that imitates human intelligence. Machines are able to paint, compose music, win a quiz show, beat the chess and go human champions. Noting the rapid development in information technology, various scholars, including Vernor Vinge, have predicted that general machine intelligence will surpass that of human in the near future; Vinge called the moment singularity (Vinge, 1993). Moreover, the development of robotics has progressed rapidly, and a number of machines have been built that imitate various human behaviors. However, concerns exist, as attempts are also underway to build robots for military use that are capable of killing people autonomously.

While recent advances in AI and robotics do seem to indicate that machines may surpass humans in the future, there is also an opposing possibility. Although machines do excel over humans in some areas, such as calculating large numbers, memorizing large volumes of data, running quickly and lifting heavy weights, machines have difficulty imitating certain tasks that humans can perform rather easily; this is known as Moravec’s paradox (Moravec, 1988). For example, distinguishing between cats and dogs, an easy task even for children, has until recently been rather difficult for computers. Moreover, simple tasks such as casual walking, which constitute innate ability in humans, are rather difficult for machines to imitate. In an era of such great strides in technology, particularly involving AI and robotics, it is interesting to address the differences and similarities between humans and machines at the fundamental level.
Problems in Physics

In physics, it is generally believed that two major laws, namely, quantum theory and relativity, govern the dynamics of the universe. Quantum theory describes the mechanisms of microscopic objects, such as atoms and elementary particles, while relativity explains the way macroscopic objects, such as a baseball or galaxies, interact. While the two theories have enjoyed unprecedented success in explaining natural phenomena, they also have some significant shortcomings. For instance, the thermodynamics of black holes present a great puzzle, particularly in demonstrating the inevitable incompatibility between quantum theory and general relativity (Bekenstein, 1973; Hawking, 1976). After decades of intensive efforts, two laws with unparalleled precision remain contradictory to each other. Similar to the black hole problem, the cosmological constant problem provides another serious challenge to the current physics establishment; that is, the discrepancy between the prediction of quantum theory and the observation is in the order of $\sim 10^{123}$. Similar to black holes, after years of attempts, the problem regarding vacuum energy is still considered to be unsolved.

Figure 1. It is recognized that there are an infinite number of real numbers between the natural numbers 0 and 1. However, in reality, there is only a finite number of atoms or molecules making up the line connecting 0 and 1. The infinite number of real numbers exist only in thought.

Numerous attempts to resolve the black hole and vacuum energy problems providing no satisfactory answer lead us to contemplate the possibility that there may be a flaw in the way we view and understand our universe. What might this misunderstanding be? One of the important implications of quantum theory and relativity as two prime rules that describe the universe is that they should also explain phenomena involving humans. That is, at least in principle, quantum theory and general relativity should, for example, be able to predict the stock markets, cure cancer, and resolve political turmoil. However, as certain scholars suggest, humans may possess an ability that is not explainable in terms of physics even in principle: Could this unexplainable aspect be related to the possible flaw in the way we currently view the universe such that we are faced with serious inconsistencies such as the vacuum energy problem?

Science vs Philosophy

Historically, science has been mainly formed on the study of materialistic systems. Although certain scientific disciplines do attempt to unravel mysteries involving mental activities, it is thought by much of the scientific community that conscious phenomenon is a byproduct of physical systems, i.e., the brain. Unlike science, philosophical investigation dealt with both physical and mental aspects from the start. Plato introduced the idealistic mental world, a suggested proof of this being that the mind envisions the idea of a perfect circle, which does not exist in the physical world. While focusing on a number of practical matters such as astronomy and biology, Aristotle introduced the term metaphysics, which attempted to find a reality associated with physical systems.

The rationalist movement of the seventeenth century began with René Descartes, who attempted to apply strict reasoning to the extreme and argued that conscious thought (i.e., as opposed to physical objects) surely does exist. Irish empiricist George Berkeley even insisted that it was the mental world rather than the material world that exists. In particular, Descartes introduced the concept of dualism, i.e., mind and body as two distinct entities. Indeed, the so-called mind-body problem, which attempts to address the relationship between mental and physical systems, has been debated among scholars for centuries.

While a number of philosophers considered mentality a primary aspect of existence, there have been others, such as the seventeenth-century English philosopher Thomas Hobbes, who considered the entire universe and the mind as a materialistic machine. Friedrich Wilhelm Joseph von Schelling also held a similar view by valuing nature and arguing that the mind results from matter, a view similar to one shared by many scientists today, i.e., that the physical brain produces consciousness.
Consciousness Without Brain

One of the most significant figures in analytic philosophy of the twentieth century, Ludwig Wittgenstein, argued that the discussion of philosophical issues ought to be based on the analysis of language and claimed (Wittgenstein, 1922), therefore, that one must be silent on issues that cannot clearly be stated in language, with the following quote:

"Whereof we cannot speak thereof we must remain silent"

Analogous to Wittgenstein's discussion, in the nineteenth and twentieth centuries, important and related discussions demonstrated the fundamental limitations in various contexts. For instance, in 1891, Georg Cantor showed that discrete natural and continuous real numbers do not match. As shown in Fig. 1, one understands that there exists an infinite number of real numbers between the natural number 0 and 1. However, in the actual world, there is only a finite number of physical dots between 0 and 1. That is, due to irreducible atoms or elementary particles, the continuity of real numbers exists only in thought.

As shown in Fig. 2, it may be convenient to represent the physical system with the net, that is, analogous to discrete natural numbers, and the mental aspect with the continuous sea. In such a visualization, Cantor's diagonalization proof hints at why continuous consciousness is fundamentally different from discrete physical systems; that is, discrete physical systems such as the brain may not be able to produce continuity of mental activities.

In the past century, there have been various studies showing results similar to Cantor's. For instance, in mathematical logic, Kurt Gödel proved it is not possible for a non-trivial formal system to be both consistent and complete (Gödel, 1931). In computer science, Alan Turing proved that the discrete computing machine cannot compute in deciding if the machine will halt or loop forever (Turing, 1936). The possibility of non-computable elements in consciousness based on Gödel's theorem and related results discussed above have been proposed in great detail by Penrose (Penrose, 1989).

Recently, various scholars have suggested a possible connection between quantum theory and consciousness. For instance, Penrose and Hameroff have suggested that a quantum effect may take place in the brain and pointed to microtubules as a candidate (Hameroff, 1998). On the other hand, the neuroscientist Karl Pribram has suggested that memory may not be localized in specific regions in the brain (Pribram, 1999). However, there has been criticism of approaches to finding quantum effects in the brain, noting that the brain is too warm for a quantum effect to take place (Tegmark, 2000).

While it is debatable whether there exists any quantum effect in the brain, another proposal has been made that approaches consciousness without directly referring to brain science. For instance, Rudolf Peierls proposed the observable in quantum theory as a representation of the observer's knowledge (Peierls, 1991) (also see (Burt, 2018)). Representing the observer's conscious state with the density matrices of observables in quantum theory is not only natural, considering the Copenhagen interpretation, but convenient because it does not directly involve the sophistication of the brain.

Subjectivity vs Objectivity

Taking the observables as the mathematical representation of consciousness leads to the subjective limitation of scientific approach as hinted at in the Copenhagen interpretation of quantum theory. However, is this approach reasonable? Indeed, there have been a number of scholars who thought scientific endeavor ought to reveal an objective reality. For centuries, one of the major debates in philosophy regarding the
fundamental nature of human knowledge has been whether it is absolute or relative, subjective or objective. For example, modern philosophy began with rationalism involving figures such as Spinoza and Leibniz, who pursued and emphasized absolute knowledge through rigorous reasoning. On the other hand, empiricists, particularly in Britain, insisted that ideas are obtained through experience, i.e., relative or subjective. For instance, John Locke argued that one is born with a blank state of mind and gains subjective knowledge through observation.

While there appears to be a great clash between rationalism and empiricism, objectivity versus subjectivity, it was the German scholar Immanuel Kant who provided a thorough analysis of the co-existence of both schools. Kant argued that while one is subjectively aware of physical objects through observation, one builds an objective conception through reasoning about the observed physical system.

In the analysis of language, the concept of universal grammar has been proposed to explain the abrupt capacity of children to speak sophisticated language (Chomsky, 1959). Moreover, in anthropology, Lévi-Strauss has argued for the existence of a universal culture that a group of people seem to share a priori (Lévi Strauss, 1955). That is, a person is born with an innate capability to speak a language, and this innateness may also be shared among people. It has been argued that this innateness of language and culture may correspond to the continuity of consciousness, i.e., the non-computable element of mind as shown in Fig. 2.

Existentialism
The arguments about limitations in various disciplines appear to resemble the fundamental difference between the physical discreteness (machine) and mental continuity (human), as seen in Fig. 2. In fact, these arguments are based on a concept known as self-reference, an essential element of consciousness. One of the major developments of twentieth century philosophy was existentialism, and it bears a number of connections to the discussion of consciousness and quantum theory, particularly in the element of self-reference.

a) Mental and physical entities are not separable
The founder of phenomenology, Edmund Husserl, pointed out that a conscious observer and the physical objects he or she observes are inseparable. Martin Heidegger extended Husserl’s idea further and introduced the term dasein, i.e., being in the world, implying that the conscious observer and the observed world are indeed fused together (Heidegger, 1962). This idea of inseparability is similar to the argument resulting from quantum theory, under which the usual separation between the observing party and the object in the orthodox interpretation leads to a contradiction because of the failure of symmetry in the case of self-reference and the conclusion that the two should not be separated. This is an important challenge to the usual premise in the scientific study, which has assumed an objective existence of a physical
system, i.e., including the observer, in certain space and time.

b) Past, present, and future intertwined
Another important concept discussed in existentialism is time. While traditional science has pursued its investigations based on linear time, Husserl used the terms retention and protention to argue how past and future together should comprise the conscious experience of present. Heidegger presented a similar argument that the past, present and future together form a being.

It has been suggested that to circumvent the problem of self-reference in consciousness, one may introduce the concept of cyclical time as opposed to linear time, and it has been shown that the physical part progresses in time in a forward manner while the conscious experience of time moves backwards, which together establish a conscious observer’s experience of the universe (Fig. 3). Although the motivation and the approaches were rather different, the cyclic model of time bears resemblance to the concept of time in existentialism in the sense that past, present, and future together establish an existence.

c) Thought and continuity
Another important figure in the existentialist school is Henri Bergson. In particular, his idea of an inner flow of time within consciousness is similar to the model of the observer’s continuous consciousness filling up the discrete physical universe. Bergson discussed the two different aspects of time, observing that while physical time is discrete, the inner time experienced through the consciousness of the observer is a flow.

Verification
While machine and human do share similarities (Fig. 4 (ii)), as witnessed with the development of AI, there are non-computable elements in self-referential consciousness that machines will never be able to duplicate, as Cantor’s proof hinted at more than a century ago (Fig. 4 (i)). On the other hand, one of the important criticisms of various suggestions connecting quantum theory and consciousness has been the lack of experimental verification. The question then arises whether the new way of viewing the universe, which is similar to the ideas of existentialism, may resolve the problem involving black holes and the cosmological constant problems discussed earlier. Indeed, it has been discussed that the model seen in Fig. 3 may explain black hole information loss by taking the inside of the horizon to be the negative sea of consciousness filling up the outside (Song, 2014). Moreover, the model was analyzed such that the quantum evolution should correspond to the nondeterministic computation going backwards in time that fills up the classical vacuum, thereby providing a consistent explanation for the dark energy problem (Song, 2017).

References

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