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IRREDUCIBLE PRIMARY CONCEPTS, OBJECT DATABASES AND EXPERIENTIAL SYSTEMS

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Irreducible primary concepts, Object databases and Experiential Systems

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Abstract

Every low-level concept denotes or subsumes a set of instances in the physical world that can be differentiated from other instances. At the highest level we have the concept of an existent, or anything that exists. In an object database the object types correspond to low level concepts and object instances to instances of existents. The Law of Identity states that any instance is what it is, that is, has an intrinsic nature that can be discovered by scientific research, enabling discovery of attributes of existent instances. A concept can normally be explained in terms of other concepts, except when it is an irreducible primary concept. However, the Law of Identity enables discovery of attributes of instances denoted by irreducible primary concepts, permitting them to be used to construct useful machines.

There are two types of awareness, namely response-capability awareness and experiential awareness. Response-capability awareness occurs in a robot, or in a database system employing integrity constraints, and is the capability of responding to the environment; it can be explained using computer systems principles, and is thus not an irreducible primary. Experiential awareness is the ability to both respond to and experience the environment, and is an irreducible primary. Because experiential awareness occurs in nature, it is an existent, so that the Law of Identity applies. This means that it must be possible to discover what the attributes of experiential awareness are, and make use of that knowledge to build experiential machines and systems.

Key Words. Awareness, computer, consciousness, concept, database, existent, experiential, identity, machine, system

Introduction

In recent years there has been considerable investigation on the part of philosophers [4, 5, 6, 12, 13] computer scientists [10], neurophysiologists [7, 8], and physicists [1, 3, 11] into an explanation for the phenomenon of experiential consciousness. For some scientists, unfortunately, the subject matter of such investigations is still considered too nebulous to be worth serious scientific consideration. The majority of scientists and philosophers nowadays would disagree however, and would be united in their belief that there really is a problem worth investigating, but would be disunited in their various beliefs as to what that problem really is and as to how to go about investigating it [2, 5, 13, 14]. In this paper we show that much of the confusion is due to lack of clear and objective understanding of the function of concepts, and that only by clarifying the conceptual basis is it possible to clearly understand exactly what the problem is.
Using an objective approach to concepts, along the lines of that used in object-oriented programming languages and databases, it becomes obvious that experiential consciousness is a fundamental concept, or an irreducible primary concept, that is, a concept that cannot be explained in terms of anything else. It also becomes clear that despite this, it ought to be possible to discover the properties and attributes of experiential consciousness and make use of this knowledge to enable construction of an experientially conscious machine or system.

**Concepts**

Every word in the English language denotes a concept, or more precisely an object class. If the word denotes a typical low-level concept, that word simply denotes a set of instances in the physical world, such as the set of real automobile instances, for example, corresponding to the word, concept or object class *automobile*.

The real instances underlying a low-level-concept word such as *automobile* or *dog* or *person* cannot be chosen randomly. For any low-level-concept word, such as *automobile*, the set of instances which it subsumes have specific characteristics or attribute types in common, e.g. is self-mobile, has a motor, etc. which distinguishes and isolates these instances from other instances of things in the physical world, such as a specific cat instance, and which usually allows them to be united under the umbrella of a specific definition. The *values* of the attributes of the common characteristics, such as, for example, a gasoline motor, versus a propane motor, are ignored in forming the concept; the fact that automobiles have motors is sufficient.

Thus a low-level concept may be defined as: a human-brain generated aggregation or integration, denoted by a word, of a set of instances in the physical world with distinct characteristics or attributes, with the specific attribute values for those distinguishing characteristics ignored.

A few low-level-concept words, while subsuming a distinct set of instances, do not permit a definition in words. For example, the word *red* cannot be exactly defined, since there is no way to know if one person's experience of red is the same as another's. A red instance in the real world could conceivably give rise to my experience of red in Person A but give rise to my experience of green in person B, and vice versa, and nobody could ever find out if this was the case. However both persons A and B would be able to sort red and green object instances correctly. Such words are said to be defined ostensively, that is, by pointing to instances of them and saying "red".

The human brain is able to generate higher-level concepts from instances of low level concepts in the same way in which it generates low-level-concepts from instances in the real world. This is a critical step on which all understanding of reality depends. The brain's initial registration of an instance in the real world is usually called a percept. Thus the brain first integrates percepts with common distinguishing characteristics to form low-level concepts, and this is the basis of all human knowledge.
The brain's next step is to integrate instances of concepts with common distinguishing characteristics to form higher level concepts. For example, automobiles, vans, trucks and buses all have a distinguishing characteristics that permit them to be subsumed by the concept vehicle. And, of course, the lower-level automobile has, or in object-oriented programming terms, inherits, all the characteristics of a vehicle. In old-fashioned language, an automobile is a species of the genus vehicle. At the next level, up the species concepts vehicle, ship, aircraft and spacecraft are subsumed under the genus concept mobile transporter, and so on.

This process of concept integration can continue to very high levels, that is, high levels of abstraction. But no matter how high (or abstract) the level of integration, a word can always be understood by firstly, referring to the underlying concepts subsumed, and their subsumed concepts, and so on, all the way down to the underlying percepts or instances in the physical world, and secondly, by stating what it is that differentiates all of these instances subsumed under the concept from other instances. If this cannot be done with a word either you do not understand the word or it has no meaning.

If we continue with the level of integration we arrive at a level where every instance of anything in the physical world is either an entity or process (or event or system). If we go the next step up, we have the concept of an existent, that is, something that exists. And of course, an existent can denote any instance in the physical world, or any percept. We can go no higher.

**Aggregation concepts**

We can also aggregate the instances of existents in the physical world in a more functional manner. Thus an engine object instance is an aggregation of other object instances, such as sparkplugs, pistons, crankshafts, and so on. All kinds of concepts, whose underlying instances are themselves aggregations of other object instances immediately come to mind, such as automobile, crane, pump, and even person and tree, or even planet, of which the Earth is an instance, consisting of a molten core instance, a crust instance, several ocean instances, an atmosphere instance, and so on. We can thus have have aggregation concepts that are very large in spatial extent, such as a planet, or a galactic cluster. We can also have aggregation concepts whose underlying instances can be extensive in both space and time, such as an empire, for example, the Roman Empire instance, which lasted about 900 years and covered most of Europe, and part of Africa and Asia.

How far can we carry this on? What aggregation concept subsumes the most extensive instances in space and time? Such a concept must be one that aggregates all existents, that is, all instances of everything in a functional manner. This concept is existence, or the unfolding universe, and it has only one instance.
Existence is a difficult concept. One thing we can say about existence or the unfolding universe that is absolutely true is that existence exists, that is, that existence is real, or that the unfolding universe is real and unfolds in space and time. We cannot state all the existents that are aggregated to make it up, since we do not know all the existents in existence, that is, in the unfolding universe. As scientists we are continually trying to find out, however.

Concepts and data bases

Now all this may appear rather theoretical and abstract and not at all practical. However, I attended a conference recently on databases at which, during one session, there was a heated discussion among participants concerning Aristotle and concepts. The practical problem is that there are a lot of data bases in existence today and many people would like to integrate them. But this has proved nearly impossible to do because each relation and each attribute in a database relation fundamentally denotes a concept, and in different databases concepts that should be the same are actually not the same, often because of errant definitions.

Concepts and the reasoning process

I mentioned Aristotle, whose light continues to shine down through the centuries. It was Aristotle who pointed out that Man is a species of the genus animal, and that what differentiates Man instances from other animal instances is that Man can reason; hence the famous definition: Man is the rational animal.

Humans reason first of all by stringing concepts together to form propositions about reality, e.g. "the sky is blue", which inform them of some truth that can be observed to be true. They also do it by taking a set of propositions, called the premises, and deducing further true propositions from them, called the conclusions. To ensure a correct conclusion this must be done by a process of valid reasoning, as first pointed out by Aristotle. Now with complex premises it is very easy to arrive at the wrong conclusion, and to help humans reason correctly Aristotle came up with logic, or the study of valid reasoning. Logicians do not care whether the premises used in reasoning are true or not, as long as the reasoning is valid, for example

\begin{align*}
\text{All intelligent spiders come from planet Xon} \\
\text{Yon is an intelligent spider} \\
\text{Therefore Yon comes from Xon}
\end{align*}

Now to help with valid reasoning Aristotle came up with three rules of logic:

1. The Law of Identity, or A is A.
2. The Law of Non Contradiction, or A is not not-A.
3. The Law of the The Excluded Middle, each thing is either A or not A.
The Law of Identity, or the Law of Intrinsic Nature, says that an existent is what it is, that is, an automobile has the nature and properties or attributes of an automobile. The second Law says that an automobile cannot have the nature and properties of something else such as those of an aircraft. The third Law says that each existent in existence has either the nature and properties of an automobile or the nature and properties of something else, with nothing in between.

Of course these three Laws are not sufficient, if you want to ensure reaching a correct conclusion. You must not only have a valid process of reasoning, you must also apply it to a correct and complete set of correct and significantly propositions or facts. Most errors in reasoning are not due to having an invalid process, but to not having a complete set of correct and significantly relevant facts to work with, a condition that can be very hard to satisfy in many everyday situations, that is, due to "garbage in" leading to "garbage out".

**Reason and the nature of all things**

Now A can be any existent. Supposing we let A be an instance of the greatest aggregate we can have, that is, an instance of the unfolding universe, which has only one instance, which we also refer to as the unfolding universe or existence. The Law of Identity says that the unfolding universe has the nature and properties of the unfolding universe, it being exactly what it is. The Law of Non Contradiction says that the unfolding universe has the properties of the unfolding universe and there is nothing else outside of it, and the Law of the Excluded Middle says that there cannot even be anything in between the unfolding universe and the nothing outside of it; in simple terms, the unfolding universe is all we have to play with and it does its own thing, which it generates internally [9].

The ancient Chinese seemed to understand this. There stands the famous lines in the Tao Te Ching (the Book (ching)of the Nature (te) of the Way of Reality (tao)):

*Mankind is controlled by the Laws of the Earth*
*The Earth is controlled by the Laws of the Heavens*
*The Heavens are controlled by the Laws of the Unfolding Universe*
*And the Unfolding Universe is controlled by the Laws of its own Intrinsic Nature*

And it is the job of science to find out just what the Laws of "its own Intrinsic Nature" are.

More recently the Dutch philosopher Spinoza understood this clearly too, when he wrote his famous lines:

*You are a child of the universe*
*Just as the trees and the stars, ...*
*And whether it is evident to you or not*
*The universe is unfolding as it should.*
Awareness

And this brings us to a problem very relevant to computer science research for the next century. Part of the intrinsic nature of the unfolding universe is that it can unfold living creatures who can reason using concepts and who can also experience, that is, possess experiential awareness or consciousness. We can approach the concept of consciousness or awareness using the idea of explanation.

When we explain something we explain it in terms of something else. Thus we explain the light coming from a candle flame as being due to atoms transitioning from electrically excited states to less excited states or to resting states. We explain one thing in terms of another. But there are some things that cannot be explained in terms of anything else. For example, when electric charge was discovered in the last century, many scientists tried to explain it in terms of matter, as a kind of extension to Newton's Laws of Motion. But they could not, and today electric charge is accepted as an irreducible primary concept, that is, something that cannot be explained in terms of anything else. By the way the concept of existence or the unfolding universe is very definitely an irreducible primary, since it cannot be explained in terms of anything else [5, 13].

Now it may be that electric charge is not really an irreducible primary, and that we have simply not advanced far enough, and that one day we will be able to explain it in terms of something else. Nevertheless, for the present we must accept it as an irreducible primary concept. But notice, even though we cannot explain electric charge in terms of anything else, we can determine its nature and properties, that is, its intrinsic nature according to the Law of Identity, and use that knowledge of the behaviour of electric charge to build electrical machines, such as computers, for example. Similarly, we can discover, by scientific investigation, the nature and properties of the unfolding universe, another irreducible primary concept, in accordance with the Law of Identity, and use this knowledge to build all kinds of useful things.

Now experiential consciousness is clearly an irreducible primary, although this is not widely recognized [5, 10, 12]. Every human is capable of experiencing a wide variety of pains and pleasures, and other things too, such as the color red or the sound of music, but despite much investigation on the part of philosophers, computer scientists, psychologists, and recently physicists, many of whom believe that quantum mechanics is at the root of it somehow, nobody has ever been able to explain experiential consciousness in terms of something else. For example, we could build a robot that has a good degree of artificial reasoning power, or artificial intelligence, and we could give it visual sensors so that it could be aware of the environment and respond correctly in some limited way. We could install sensors on its exterior too, so that it could avoid getting too hot or too cold or too close to dangerous radiation sources. But this robot, while being intelligent to a degree, and while being aware or conscious of its environment, would experience nothing. And while this robot might be capable of following a preprogrammed procedure to deal with its mangled manipulator (robot hand), for example, it would experience no pain [6, 10].
Thus, while the robot would be aware of its environment to some degree, it would not be experientially aware or conscious, since it experiences nothing. It is merely response-capability aware or conscious, that is, it is merely capable of responding via its programming, to situations sensed in the environment via its sensors. If you hit it on the head with a hammer, you would not be charged with cruelty to a machine, although you might well be charged with damage to property, or worse, since it is response-capability conscious, it could respond by hitting you on the head, without, of course, experiencing either remorse or satisfaction.

It is important to distinguish clearly between response-capability consciousness and experiential consciousness. The former is in principle not a problem, and computing machines exhibiting response-capability awareness are commonplace [2]. Response-capability consciousness is therefore not an irreducible primary, since it can be explained in terms of basic computer systems principles Philosophers are inclined to consider response-capability consciousness as giving rise to the Easy Problem of consciousness, and experiential consciousness as giving rise to the Hard Problem of consciousness [5]. In spite of much research, no investigator has ever been able to explain experiential consciousness in terms of anything else. There are physicists who think it may be possible to explain it in terms of some aspect of quantum mechanic, but no convincing explanation has appeared as yet [1, 3, 11]. Hence, at least for the present, it has to be considered as an irreducible primary concept.

We have simply no idea how to make a machine experience pain or pleasure or anything else. We cannot explain experiential consciousness at all, and we cannot even create it. At least in the case of electric charge, you can create pairs of charged particle if you have enough energy.

The survival benefit of experiential awareness

Now experiential consciousness is a really useful thing to have. Its primary use is to help the possessor to survive. At the simplest physical level it seems to keep us from burning ourselves on hot stoves and ensures that we eat that delicious meal when we are hungry. But on a more sophisticated level it enables us to have emotions, which, from a systems point of view, work as follows.

A separate and independent part of the brain, which we shall simply call the emotional processor, continuously monitors the image currently being consciously considered or contemplated, or, in over simple terms, what is in the "mind's eye". This image can come directly from the environment, such as the picture of a desk in front of me, or it can come from memory, or from imagination, or from the information in a message. As well as tirelessly monitoring this image, the emotional processor continually compares the essence of it to statements of belief stored permanently and unconsciously in unconscious memory, for example statements like: "flying is too dangerous", "pork is bad", or "money is good". When the comparison is negative, the emotional processor generates negative (painful) feelings such as fear of loss, or envy, and motivates us to do something about the external
world to change this situation, the famous "fight or flight" response *(away-from motivation). And when the comparison is positive, the emotional processor generates positive (pleasant) feelings that motivates us to move forward and embrace the external environment *(towards motivation).

The experiences of pain or pleasure caused by the emotions or feelings generated by the emotional processor can be very powerful and compelling, so compelling that they often cannot be resisted by humans, which is exactly what they are designed to accomplish. There are two downsides for having this protective survival system, however. One is that it never stops operating, so that if the environment is not good, it gives you a bad time all the time. The other downside it that while it may be fast in terms of response to an image, it is not rational. It simply compares the input image to its stored statements; if an unconsciously stored statement make no sense, such as :"Teddy bears are extremely dangerous", you will still experience fear on seeing, or even thinking about, a Teddy bear.

Nevertheless, the benefits of such a monitoring system must exceed the costs, since humans have survived. We can venture to conclude that as a survival feature, experiential-awareness together with response-capability awareness, both of which are possessed by humans, must be superior to just response-capability awareness alone.

The integrity constraint subsystem in database management systems operates in a manner similar to the human emotional system. This subsystem continually checks update input against a set of stored statements called integrity constraints, and rejects the update when the constraints are violated. And just as the human cannot get at the stored statements in the unconscious memory to alter them, the user cannot get at the integrity constraints.

**Possibility of experientially conscious machines**

Since experiential consciousness is clearly very useful in systems, the really big question should by now be obvious. Even if we cannot explain experiential consciousness in terms of anything else, as in the case of electric charge, can we one day expect to understand enough about the intrinsic nature or properties of experiential consciousness to build an experientially conscious machine or robot, that is, one that could really experience pain, for example. Now many people of a more mystical inclination will object that this is getting just a little out and hand, and that anyway such a machine is impossible because humans, who possess experiential consciousness, are not entirely part of the unfolding universe; they will maintain that Spinoza is dead wrong, and that humans have a mind component apart from the material unfolding universe that makes them special.

As a scientist, I am not interested in getting embroiled in this contentious issue, however, and will sidestep it by merely pointing out something we can be absolutely sure of. The higher animals are also experientially conscious. It is obvious that dogs and chimps experience pain, for example, and we are so certain about that that we have laws to stop humans from inflicting pain on these creatures.
Since a dog or cat is capable of experiencing pain, it follows that they are experientially conscious. And since they are existents in the unfolding universe, it follows that the unfolding universe is capable of unfolding or generating experiential consciousness, and this must be happening in accordance with the properties or intrinsic nature of the unfolding universe, that is, in accordance with the Law of Identity. It follows that it must be possible to find out enough about it to build it into a machine. Biological systems clearly have no difficulty replicating it on a grand scale.

This then is the great problem and challenge for computer scientists. Build an experientially conscious machine. Such a machine's ability to experience pain and pleasure could perhaps be used to motivate it. Humans are profoundly motivated to avoid pain and seek pleasure, what the psychologists call away-from motivation and towards motivation. Humans also learn very quickly to avoid what hurts, so that an experientially conscious machine could perhaps be motivated to learn in a similar manner (Artificial Motivation). Thus the way would open to build machines that can do all kinds of things that we commonly associate with human behaviour - and who can say, perhaps things well beyond human capability. And it truly is a great problem, for apparently nobody has the faintest notion of how to do this. Yet if the reasoning above is correct, it must be possible.

We are saying that just as in the case of electric charge, in order to make use of experiential consciousness, there is no need to explain it in terms of something else. We merely need to find out enough of its properties or intrinsic nature, in accordance with the Law of Identity, to make use of it in building machines.

Summary

Every low-level concept denotes or subsumes a set of instances in the physical world that can be differentiated from other instances. Similarly, a concept at the next level up subsumes a set of concepts, and thus a broader set of physical instances, that can be differentiated from other instances. At the highest level we have the concept of an existent, or anything that exists. Thus we understand a concept if we can point to the instances it subsumes at the physical level.

We can also have aggregation concepts where any instance in the physical world is ultimately constructed of an aggregation of other instances in a functional manner, such as an automobile made up of wheel, sparkplug and other instances. The largest or ultimate aggregation concept is existence or the unfolding universe. Aristotle's Law of Identity states that any instance is what it is, that is, has an intrinsic nature that can be discovered by scientific research. Thus we can discover the properties of the unfolding universe.

Most concepts can be explained in terms of other concepts, but some cannot, such as electric charge, which is a fundamental concept, or better, an irreducible primary concept. Nevertheless the Law of Identity enables us to learn about the properties of the instances denoted by irreducible primary concepts such as electric charge, and make use of them to construct useful machines. Existence or the unfolding universe is also an irreducible primary.

There are two types of consciousness or awareness, namely response-capability awareness and experiential awareness. Response-capability awareness occurs in robots
that are capable of responding to their environment, and thus can be explained in terms of basic computer systems principles. Hence response-capability consciousness is not an irreducible primary. On the other hand experiential consciousness, the ability to experience pain and pleasure, for example, is a clear irreducible primary and cannot be explained in terms of anything else.

However, because experiential consciousness occurs in animals, it is an existent in the unfolding universe, so that Law of Identity applies. This means that it must be possible to discover, by scientific research, what the properties, attributes or intrinsic nature of experiential consciousness is, and make use of that knowledge to build experientially conscious machines.

The conclusion is that experientially conscious machines are a possibility.

References


