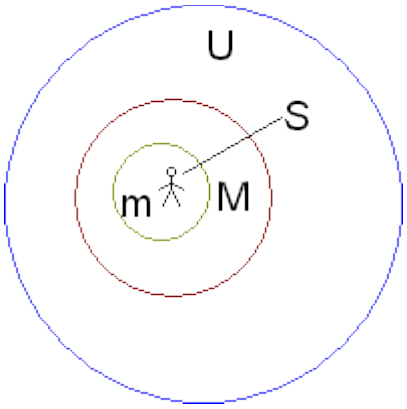
Footnote: The Fallibility of Perception

> *Truth is absolute. Perception is imperfect. Perceived truth is therefore imperfect. Each can perceive truth only from his unique position in time and space. Consequently, perceived truth is also relative. Compromise is therefore vital. Logic and Deduction*

The process of logic or deductive reasoning is popularly illustrated in the quotation "All men are mortal. Socrates is a man. Therefore Socrates is mortal.". This process is formalised as a system of algebra in which a symbol is assigned to each of the propositions.

A = All men are mortal.
B = Socrates is a man.
C = Socrates is mortal.

A graphical representation of these propositions is shown on the right. The big circle 'U' represents the universe. The smaller red circle 'M' within it represents all things mortal. The even smaller yellow circle 'm' within the red circle represents "all men". The little figure 'S' in the middle represents Socrates. Consequential relationships between the propositions are expressed through the logical operators "and", "or" and "not". In one convention, the symbol "&" represents "and", "|" represents "or" and "!" represents "not". The popular quotation above can thus be reduced to an algebraic equation C = A & B.

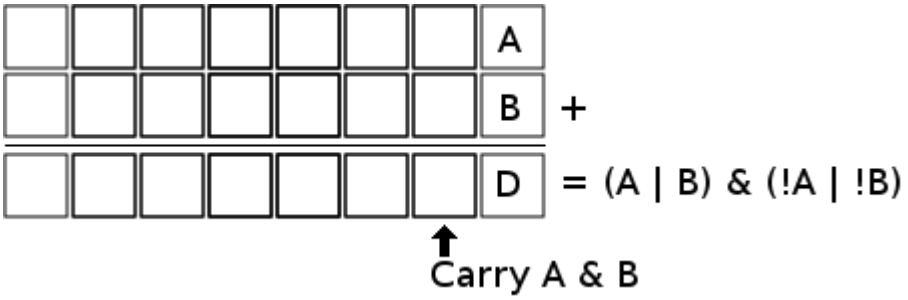


The logical equation C = A & B states that Proposition C is true provided that the Propositions A **and** B are **both** true.

The three logical operators &, | and ! are not mere conventions of human language. They are fundamental elements of natural law just like the arithmetical operators + − × and ÷. In fact, each of these four arithmetical operators can be expressed in terms of the more fundamental operators &, | and !. For instance, in arithmetic, we express the sum S of a pair of binary numbers A and B as S = A + B. We can, however, rewrite this equation in terms of the more fundamental logical operators as follows:

D = (A | B) & (!A | !B) and C = A & B

Here, D is the resulting value for the current digit position and C is the amount we must "carry" to the next higher digit position.



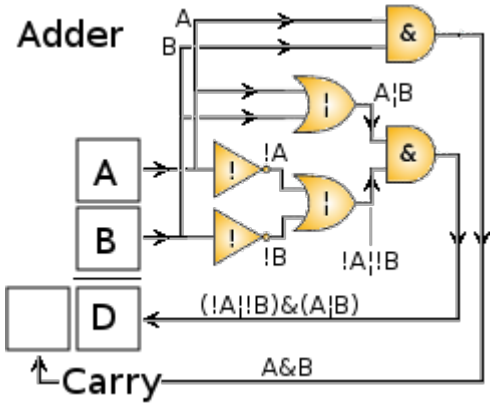
The above diagram shows how the binary numbers A and B in the least-significant column of an 8-bit register are added together, using logical operators, with the result D placed in the least-significant column below and the amount which must be "carried" to the next column. For example,

if A = 1 and B = 0, then
C = 1 & 0 = 0 [so there is nothing to carry]
D = (1 | 0) & (0 | 1) = 1 & 1 = 1
Note that !1 [not 1] = 0 and !0 [not 0] = 1

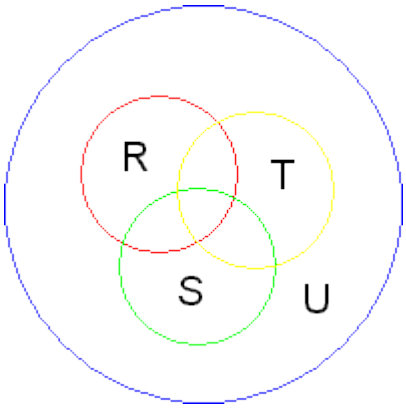
We get the same result if A = 0 and B = 1

if A = 1 and B = 1, then
C = 1 & 1 = 1 [so there is 1 to carry]
D = (1 | 1) & (0 | 0) = 1 & 0 = 0

A binary adder is implemented electronically in a computer by wiring together basic logic circuits as shown on the right. There needs to be a repetition of this circuit for each column of a 32-bit register. All but the least significant column needs additional circuitry for adding in the "carry" bit from the previous column. The existence of the electronic adder circuit shows that logic is intrinsic to the way nature works under the laws of physics. It was not invented by man, but rather, discovered by him.



In the case of Socrates discussed above, the whole of each smaller (more specific) class of objects is contained within the more general class. It is merely an instance of the human convention by which we classify a particular object - in this case, Socrates - in terms of a characteristic that it shares with other objects and *classes of objects.*



Far more interesting and useful cases occur where classes of objects overlap, as shown in the diagram on the left. For instance, if U represents the United States of America, T represents all Texans, R represents Americans who vote Republican and S represents all Americans who did not approve of Saddam Hussein, then the little rounded triangle in the middle represents Republican-voting Texans who don't approve of Saddam Hussein. Cases with overlapping classes can lead to very complex *relationships and dependencies* between propositions that are difficult - if not impossible - to reason out through verbal argument.

The process of deduction - whether by verbal reasoning or by logical algebra - is to determine the TRUTH or FALSITY of a proposition that you *want to know (but are unable to observe)* from the TRUTH or FALSITY of related propositions that you *already know because you have observed them.* The validity of your deduction depends on the validity of your observations. The validity of your deduction is therefore a matter of perception. It is about whether - and to what extent - you can

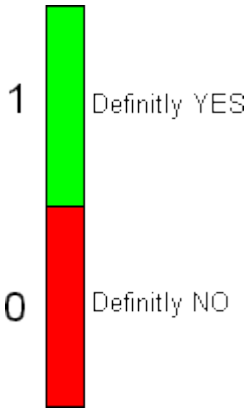
know the TRUTH or FALSITY of a proposition relating to an external event, object or phenomena that you observe.

The Black and White View

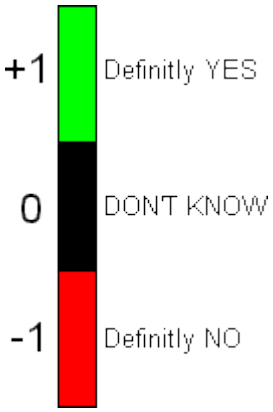
Whatever we observe, we can discover things about it by asking ourselves questions about its appearance and behaviour. All these questions can be reduced to a set of elemental questions, the answers to which are either "yes" or "no". For example, we can ask "What colour is it?". The answer must be the name of a colour. However, we can reduce this question to a set of elemental questions like "Is it red?", "Is it green?", "Is it blue?". The answer to each of these elemental questions is either "yes" or "no". Another more formal way to do this is to replace questions with propositions, then decide which propositions are TRUE and which are FALSE. For example, we can make the following propositions about an object we are observing: "It is red." "It is green." "It is blue.". Assuming we include propositions for all possible colours, then only one proposition will be TRUE and all the rest will be FALSE.

Whether an elemental proposition about an observation be true or false has been the basis for logic since ancient times. Today, this yes/no logic represented by 1s and 0s is the principle upon which computers operate.

Many people see the world in terms of this absolute two-state logic. They see "facts" as absolutely TRUE or absolutely FALSE. They view each aspect of human behaviour as being absolutely RIGHT or absolutely WRONG. They adhere to a strict syntactical interpretation of, for example, sacred scriptures, which implants within them an austere black-and-white notion of GOOD and EVIL. It engenders a bloody-minded mentality in both company employees and public functionaries who uncompromisingly expedite their interpretations of policies, rules and regulations, knowing full-well of the *officially unintended* harm and injustice they thereby may inflict on those to whom their interpretations are applied.



But Perception Isn't Perfect



Notwithstanding, this black-and-white two-state logic is not the principle upon which the real world operates. The reason for this is that human perception is imperfect. The human life-form is not equipped with a divine *all-seeing eye* that can view the whole universe with perfect vision against an absolute frame of reference. Our imperfect perception allows each of us to know some things but not others.

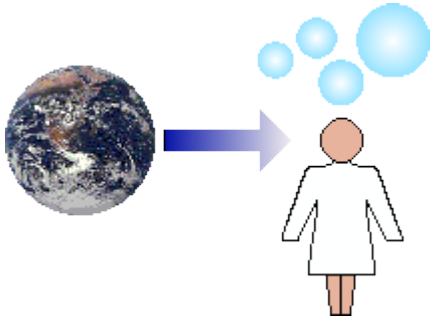
We can observe some propositions about our universe to be TRUE and some to be FALSE. However, for the vast majority of propositions about our universe, our powers of observation fail. Consequently, we do not know whether they be TRUE or FALSE. Unlike computers, communication links suffer from interference. This fogs signals to greater or lesser degrees, depending on distance and the quality of a connection. In the absence of interference, a receiver will be able to resolve definitely whether a signal is "0" or "1". However, when interference is present, it may not be sure which it is. For this reason, communication links use three-state logic: "+1", "0" and "−1". When a receiver is unsure of a signal, it asks the

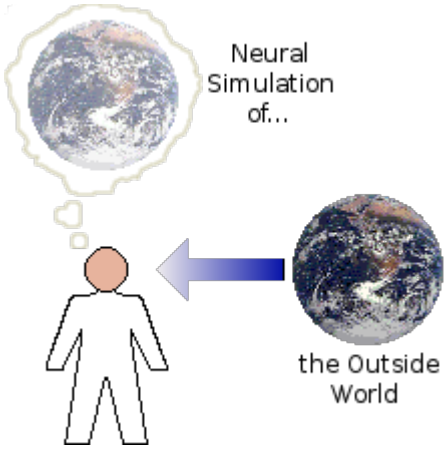
transmitter to re-send it. The receiver is thereby able eventually to obtain a good copy of the message.

But even this three-state logic is not sufficient to represent the TRUTH or FALSITY of the propositions we make about what we see in the real world. Four different factors actively diminish the certainty with which we can know the TRUTH or FALSITY of such propositions.

Sense and Interpretation

The first factor is to do with our physical senses. If we are looking at something through a morning mist or in the dusk of night, we do not see it clearly. Our eyes sometimes "play tricks" on us. Any medium that conveys information from the outside world to one of our physical senses interferes with, and degrades, that information to some degree, even under the most benign conditions. What we *see* is therefore never a true representation of whatever we are *looking at.*

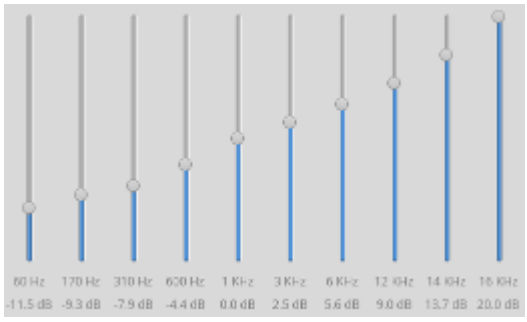




The second factor concerns one's *interpretation* of what he sees. Throughout life, one accumulates memories of all his experiences. With these, his mind constructs, and continuously augments, a neural model that simulates his world outside. One interprets what he sees by comparing his current experiences with this neural model. For him to be able to interpret what he sees correctly, his past experiences must contain all the basic elements of what he is seeing. If any of these basic elements be missing, his interpretation of what he is seeing will be inaccurate, and could be completely false.

Furthermore, the process, whereby a person's neural model is built and updated, may impose *emotional distortion* upon the information it receives from the outside world. This is particularly significant regarding how a person's mind interprets the attitudes and intents of other human beings.

I liken this to a sound equaliser with sliding gain controls to allow you to adjust an amplifier's gain for each octave of the audio spectrum. If the sliders are adjusted correctly for a given input, you get a well-balanced output. If, on the other hand, some of the sliders are significantly far from where they should be, the output is unbalanced and not pleasant to hear.



Different sliders [different octaves of the audio spectrum] represent the different aspects of human emotion. In the latter case, where some sliders are out of adjustment, the person's perception, of that emotional aspect of what he is currently experiencing, is either accentuated or diminished. This results in his neural model of the world [specifically human society] being updated in an

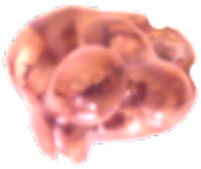
emotionally distorted way. This, in turn will cause him to have an even more emotionally-distorted view of his future experiences.

Emotional distortion thus gives a person an increasingly distorted view of human society. It can cause the person to fear people, animals and objects to an extent much greater than is necessary for reasonable levels of caution. It can also work in the opposite direction, giving him a reduced sense of danger.

If emotional distortion exceeds a critical threshold, it becomes super-regenerative. This causes a person to continually re-run horrendous "what if" scenarios that can eventually become part of his neural model of the world and thereby become perceived as having really happened. In other words, they become fear-invoked false memories, which, when used as a context for interpreting what he sees, can completely falsify his interpretation of what he is currently experiencing.

Angle of View

The third factor concerns the direction from which an object is being viewed. The object in the picture on the right is almost impossible to recognize. It looks like nothing that could be remotely described as familiar. This is because it is being viewed from a direction from which it is not normally seen.



If, however, you change the angle of your point of view by 90°, it appears as shown on the left. It becomes instantly recognizable as a carving of a man and a woman embracing. This is because it is now being viewed from a direction from which people normally view such things. Unfortunately, it is not always possible to change one's viewing position in order to find a more familiar direction from which to observe something.

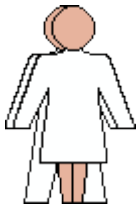
For example, an astronomer observing the motion of a planet is constrained to make his observations from the surface of the Earth. The Earth is rotating on its own axis and also revolving around the sun. The observer's own motion combines with that of the planet he is observing. This makes the planet's motion appear to the observer to be far more complicated than it really is. It confused the astronomers of the ancient world for a long time.

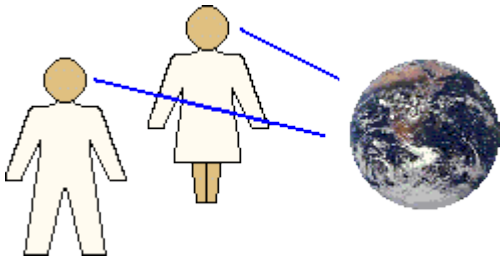
Each of us is constrained to view others from the point of view of his particular economic and cultural stations within the social order. Those of us who do not have sufficient means and influence are therefore constrained to view the rest of society from a less amenable angle. Consequently, making sense of it requires of us that much more effort.

Each View Is Different

The fourth factor is to do with the nature of the Universe regarding the fundamental constraints of time and space. It is physically self-evident that no two objects can ever occupy exactly the same position in time and space.

This idea can reasonably be extended to human observers by saying that no two people can occupy exactly the same position in space-time or society. Everybody's experience is different because the lives of no two people have ever followed exactly the same path through time, space and society. Each person's point of view is therefore bound to be different to at lease some degree. It is fundamentally barred from ever being exactly the same as somebody else's.





Hence, the precise angle from which each of us views the world is unique. Consequently, each person's perception of the TRUTH or FALSITY of propositions about the world is bound to be different from everybody else's. Each of us effectively lives in a slightly different *personalised* version of the Universe. This is evinced by the fact that no two people can agree perfectly about everything.

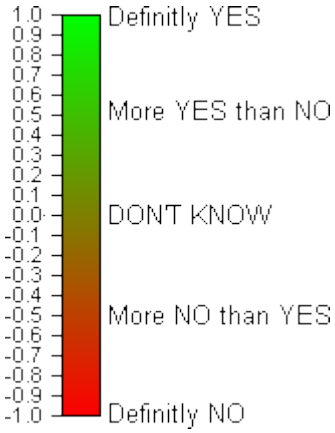
This leads people and nations to very different views of some very basic notions. For example, the word "freedom" has somewhat different meanings to different people:

O say does that star spangled
banner yet wave,
O'er the land of the free
and the home of the brave?

Sing to the Motherland
home of the free,
Bulwark of peoples
in brotherhood strong!

Logical Probability

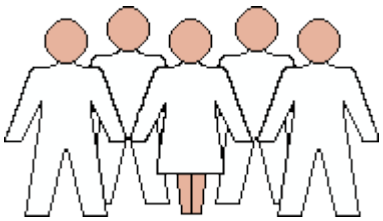
The indistinctness of human perception requires a more sophisticated version of logical switch than the two and three-state versions discussed so far. To represent the status of propositions relating to our perception of the real world, we require a form of logic that varies infinitely and continuously all the way from *definitely TRUE* to *definitely FALSE*. This accommodates the fact that *perceived* truth can only ever be a fuzzy version of the *real* truth. This type of logic can be regarded as a measure of the *probability* of the TRUTH or FALSITY of a proposition relating to something in the real world. Instead of stating whether a proposition be TRUE or FALSE, a person guestimates a numerical value between −1 and +1.



For example, a value of +0·5291166 means that through the fog of his senses and the errors of his perception, he estimates, from what he sees, that the proposition is 53% likely to be true.

This logical probability must not be confused with the probability of an actual event occurring. Logical probability is different from, for example, the statistical probability with which an actuary predicts real movements in a financial market. It is a probability of perception: not of fact. One's perception of an observed event can be thought of as a mixture of truth and error. For example, if you estimate that a particular proposition be +75% (75% TRUE) then you are saying that your estimate, based on what your senses and experiences are telling you, probably comprises ¾ truth and ¼ error.

The Advantage of Consensus



When many people make considered judgements about their independent observations, what they agree about will be more likely to be correct than what they disagree about. This is because truth originates from the *universal* reality without while error originates from the process of perception within each *individual* mind. A much better approximation to truth is therefore always acquired by consensus and compromise.

Notwithstanding, for consensus to work, each individual must apply considered and separate thought to what he is observing. Each must be an independent thinker and judge: not a sheep blindly following the dogma of an elite minority or exigent leader. An example of the latter is the dogma that the Earth was flat. This was foisted upon a world of willing sheep by a church that condemned the one man who dared to publish his unfettered empirical observation that the Earth was in fact spherical.

A much better approximation to the truth is always acquired by consensus and compromise. However, this introduces a further element of error. When one makes a judgement as to the probability of an observed proposition being true, the process takes place entirely within one's mind. It involves nobody else. But consensus and compromise take place *between* people. This necessitates inter-personal communication, which requires the use of language.

The Problem of Language

Language is symbolic. Objects and actions are represented by words. A word almost always shares no fundamental characteristics with what it represents. For instance, neither the sound nor appearance of the word "dog" bears any resemblance to the animal that barks. Therefore, to convey accurately a message involving a dog, both the speaker and the listener must have had previous sight or sound of that type of animal. The speaker and the listener must both attach similar experiences to the word "dog". A dog is a physical thing. Certainly, a person who has seen any animal with four legs could eventually come to understand - at least in part - what a dog is, even if he had never seen one. However, without ever having seen one, his understanding could never be perfect.

This imperfection becomes far more significant when we consider what a particular speaker means by an abstract notion like "freedom". This is impossible to know exactly unless the listener has direct experience and appreciation of the speaker's life, background and belief system. No two people have ever trodden exactly the same path through life. Each individual's battery of elemental experiences is therefore different. Consequently, no two people can mean exactly the same things by exactly the same words. In any verbal exchange between people, the meaning conveyed is necessarily fuzzy. Often - especially through the narrow sub-language of bureaucracy - it can become impossible to convey the *overall* truth without telling *detailed* lies.

Social Consequences

A stark witness to the way meaning is warped by the fuzziness of human perception and communication is the grand diversity of religions that exist in the world. Even variants of what is purportedly the same faith are often irreconcilably incompatible. The same is true of political ideologies and schools of academic thought.

If harmony is ever to emerge from this cacophony, each of us must realise that the logic of the real world is fuzzy. We must each make careful observation and sincere independent judgement of the *truth probability* for all the propositions we encounter in all areas of human thought and belief. Then all of us must share our observations and judgements in a spirit of consensus and compromise. Religious and political dogma will then disappear. Academic egotism will evaporate. Such freedom of thought could lead us to discover things like a solution to the inequities of capitalism by incorporating within it some ideas from communism, or resolutions to the paradoxes of Christianity within the tenets of Buddhism.

Once we all recognise that observed truth has a *probability* and not a *certainty*, we can perform the same computations of logical algebra to derive unobservable truths. The same logical operators (AND, OR, NOT) work equally for fuzzy logic as for the inflexible two-state logic of the ancients.

All is Opinion

Nothing spoken or written is fact. Any statement is merely a subjective observation, which is relative to the originator's unique path through the experience of life. It can only ever be an opinion that has a certain *probability* of being fact. To maximise this probability, many can pool their observations. But this demands that each respect the points of view of others equally as his own.

All observation is relative to the unique path through space, time and the experience of life of each individual. All that is said and written is derived from observation. Consequently, all that is said and written is also relative to each individual's unique experience of life. All that is said and written is therefore necessarily individual opinion: not universal fact.

In the context of individual responsibility, the question can never be whether what somebody says or writes is factual or not. It can only ever be a question of whether the speaker is stating an honest opinion or a malicious one. This could have implications regarding the validity of established laws relating to slander, libel, misrepresentation and defamation. The default assumption about anything that is said or written must always be that it is *opinion.*

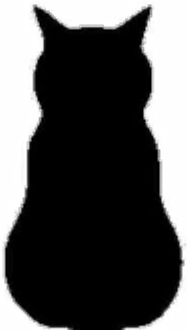
Quantum Uncertainty

I have, thus far, considered only the probability with which we are able to know the truth or falsity of a proposition constructed from what we observe with our own senses. Such observations can only involve things that are big enough to see (with magnification if necessary). On this *macroscopic* scale, as it is called, I can reasonably assume that what I see must be an albeit imperfect view of a concrete objective reality in which all propositions are, definitively, either true or false.

For example: the proposition "my cat is dead" is necessarily either true or false at any given time in any given place. My cat cannot be both alive and dead at the same time in the same place. In our macroscopic world, the two states-of-being - alive and dead - are mutually exclusive. Due to the fallibility of my perception, I may not be able to see clearly whether my cat is alive or dead. But this has absolutely no bearing on whether my cat is actually alive or dead.

Notwithstanding, once we venture down into the so-called *quantum world*, at scales significantly smaller than the wavelength of light, we enter a realm in which facts themselves only have a certain probability of being true. Furthermore, it would seem, a fact can be both true and false in the same place at the same time. In other words, things on this scale can exist coincidently in two mutually-exclusive states-of-being. At least this is my best understanding of what scientists are saying.

Schrödinger's Cat



To illustrate this notion, Erwin Schrödinger made an analogy with a cat, which could be both alive and dead in the same place at the same time. Schrödinger put his cat in a closed box. Also in the box he put a lethal source of gamma rays, which was contained in a radiation-proof vessel. He included a mechanism with a random trigger above the container of the gamma ray source. The mechanism could break the container at any random time, thus releasing the deadly radiation, which would kill the cat. At any given time, therefore, the cat could be alive or dead.

Since the box is sealed and since the mechanism that breaks the container can trigger itself at any random time, no outside observer can know, at any given time, whether the cat is alive or dead. To him, the cat has an equal probability of being dead as of being alive.

We must, of course, ignore the strong likelihood that the cat would suffocate anyway in a sealed box. Notwithstanding, the corollary to this scenario is that Schrödinger's cat, while it is sealed in the box, is both alive and dead at the same time. It exists in a state of life and in a state of death coincidently.

This is what, I am given to understand, is called a *superposition of states*. But, zombies notwithstanding, life and death are *mutually exclusive* states of existence. Consequently, the story of Schrödinger's cat seems to me to be asserting that, at the *microscopic* scale, a finite-state mechanism can exist coincidently in two mutually-exclusive states, which is a logical absurdity. It is no more than a play on words; an implicit self-contradiction.

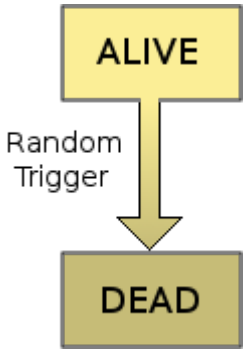
It is only when the observer opens the box that he is able to see the cat's definite current state-of-being: namely alive or dead. But it gets worse. Schrödinger's analogy asserts further that the cat's state-of-being only becomes definite *when* the observer actually opens the box. In other words, it is the very act of opening the box (the act of observation) which puts the cat into one mutually-exclusive state-of-being (alive) or the other (dead).

This assertion is contrary to all that is, or has been, perceived by human experience. The act of opening the box cannot kill the cat or leave it alive, unless the lid of the box is somehow linked mechanically to the mechanism that breaks the container of the deadly radiation source, which is understood not to be the case.

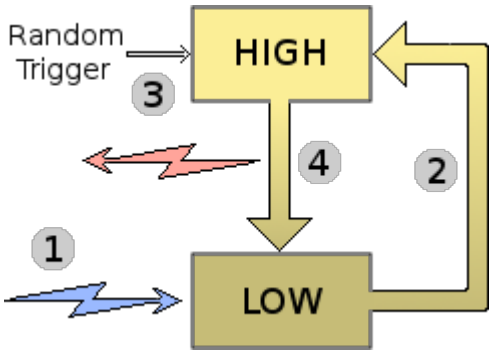
The story of Schrödinger's cat asserts that the probability of the cat being alive or dead, when the box is opened by an observer, is an intrinsic attribute of what is being observed; as opposed to being due to imperfections intrinsic to the observer's means of perception. At least, this is how the story has always come across to me.

A Finite-State Machine

In the context of his thought experiment, Schrödinger's cat is a kind of finite-state machine with only two possible states: ALIVE and DEAD. Schrödinger's experiment has the systemic profile of a bomb with a random trigger. It is going to explode but nobody knows when. And when it does, it can never do it again. It can only ever change its state-of-being once. It is non-reversible. Schrödinger's cat could represent some mechanisms in the microscopic world, such as the decay of a radioactive atom, which, beyond the super-hot core of a giant star, is essentially non-reversible.



Most finite-state mechanisms of the microscopic world appear, however, to be able to change their states-of-being in either direction, and without limit.

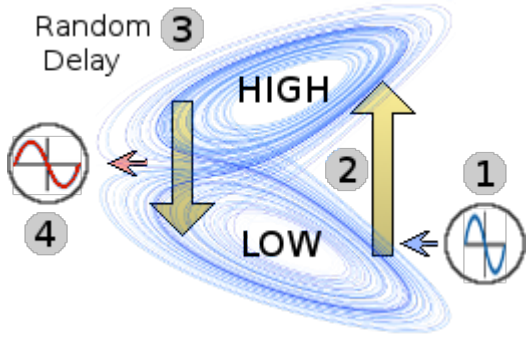


My understanding of how such a machine should operate is illustrated on the left. The machine is in its low-energy state. It is hit by a travelling disturbance (1) which imparts energy to it. This raises (2) the machine to its high-energy state. After a random delay (3), the machine falls back again to its low-energy state (4). In the process of so doing, the machine creates a fresh disturbance in the space around it, which travels outwards away from it.

To be able to hit the machine into a particular higher energy state, the amount of energy in the incident disturbance (1) must be between certain critical limits. So also must be the period within which this energy is completely delivered to the machine. In fact, the incident disturbance has many other critical parameters such as spin, momentum, relative angle of incidence and so on. Likewise, the parameters of the emitted disturbance (4) are determined by the precise manner and timing extant when the machine falls back to its lower energy state.

Abstracting the parameters of the disturbances (1) and (4) from their physical embodiments, we have input and output messages respectively to and from the finite-state machine. Our model thus becomes a message-driven finite-state machine (or finite-message machine).

The delay before the machine falls back to its lower energy state seems to be random. This suggests to me the presence of chaos. The higher energy state may therefore host a complex dynamical process, like a weather system within the Earth's atmosphere. An intrinsic characteristic of complex dynamical systems is their sensitive dependency on initial conditions. This, which is also known as the *butterfly effect*, could well be the author of this randomness.



Thus the whole machine could simply be a twin-lobed complex dynamical system, which, when hit by an incident disturbance (1) is pushed (2) onto its upper lobe. Then, after an apparently random delay (3), it falls back to its lower lobe, releasing its excess energy as the emitted disturbance (4). Although the delay appears to be random, it is deterministic. It's just that the determinism is very complex, thereby creating an illusion of randomness.

The butterfly graph is, of course, unrelated to the physical structure of the microscopic machine itself. It merely represents the apparent *behaviour* of the machine from the point of view of an outside observer. My best understanding of the physical embodiments of these microscopic machines is as follows.

I imagine them to be complex 3-dimensional structures of standing waves, held in dynamic equilibrium by opposing force fields, which have differing forms and degrees of non-linearity. Each state-of-being of such a machine is thus a stable or meta-stable standing wave, upon which may be modulated a complex melody of chaotic sub-oscillations. The form of this melody, at any given time, is probably determined by the precise way in which the machine was hit into its higher state. And this determines the amount of the delay before it falls back to its lower state.

Different Worlds

My intuitive difficulty with the story of Schrödinger's cat is that it is a macroscopic analogy of something which takes place on the microscopic scale. Schrödinger's cat, in the context of the story, is a finite-state machine, which can be, at any given time, in one of two possible mutually exclusive states-of-being: alive or dead. In the analogy, it is being used to represent a microscopic finite-state mechanism, such as an atom.

There is, however, one fundamental difference between the macroscopic and the microscopic worlds. And that is the difference in their relationships to light. At the macroscopic scale, a cat's body reflects light. The observer's eye can see this light. The observer's brain can parse the details of the image of the cat conveyed by the light. Thereby the observer can know the cat's state-of-being when he opens the box. He can see whether it is alive or dead. But above all, at the

macroscopic scale, the light itself cannot affect or change the cat's state-of-being. The light that falls on the cat, and renders it visible, cannot kill it.

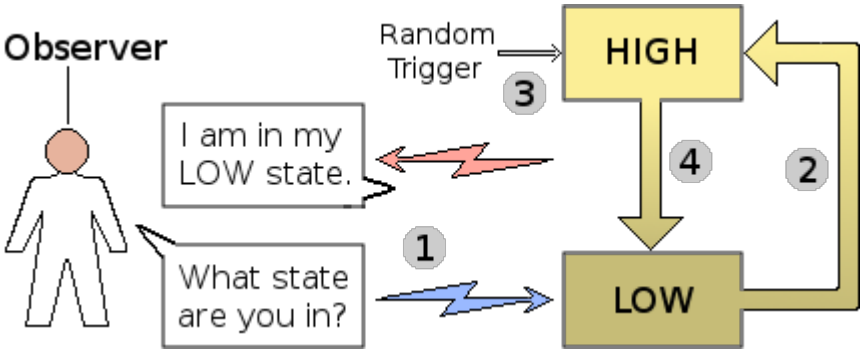
At the microscopic scale, on the other hand, Schrödinger's cat, while in a stable state, does not reflect - or otherwise emit - light, or indeed anything. It conveys nothing about itself to the outside world. To any outside observer, it is invisible. It is as if it doesn't exist. Consequently, an observer - no matter how sophisticated his instrumentation - has no means of knowing in which of its two possible mutually-exclusive states-of-being Schrödinger's microscopic cat currently exists.

Shining light on Schrödinger's microscopic cat would be like trying to make a detailed observation of a pebble by bowling a large ocean wave at it. Any reflected energy would be so diffuse that it would convey no detail whatever. Even firing electrons (incredibly small wave-particles) at atoms, as when viewing them through an electron microscope, reveals nothing more than somewhat fuzzy looking balls with nebulous lobes. The degree of detail is vastly insufficient for an observer to be able to discern an atom's current internal state-of-being.

To be able to view an atom in sufficient detail to perceive its internal state, it would be necessary to fire at it wave-particles of such high energy that they would themselves knock the atom into a different state. It would be like trying to view Schrödinger's normal size cat, not by shining light on it, but by firing bullets at it and monitoring how the cat's body deflected them. It is obvious that by doing this, the method of observation would affect the cat's state-of-being. They would kill the cat. Consequently, the observer could not know if the cat had been killed by his bullets or if it were already dead before he made his observation.

Same Fallibility of Perception

The cat is an extreme analogy. An act of observation does not necessarily destroy an atom or smash it into pieces. It simply hits it into a higher energy-state. In the general case, the atom acts towards an observer as a message-driven finite state machine. Systemically, the observer sends an interrogative input message: "What state are you in?". If the machine is in its lower state, this act of observation will kick it into its higher state. After a random delay, the machine emits an answer: "I am in my LOW state", which was, and now is again, true.



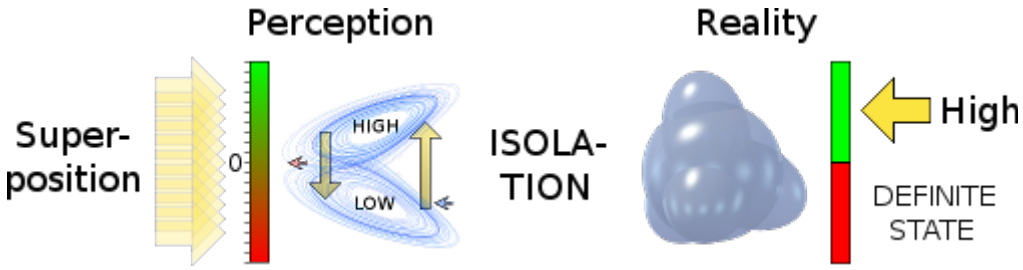
It could, however, already be in its HIGH state. Countless particles are flitting about all the time, any one of which could, unbeknown to the observer, hit the atom into its HIGH state. So if, on the other hand, the machine were in its HIGH state when the observer's interrogative message hit it, it would not be able to absorb the energy. It would therefore ignore the message. Nevertheless, after an indeterminable random delay, the machine must naturally return to its LOW state, thereby emitting an output message saying: "I am in my LOW state".

The observer can never receive a message from the machine saying: "I am in my HIGH state". Consequently, the observer fundamentally has no way of knowing what state the machine *was* actually in when he asked his question.

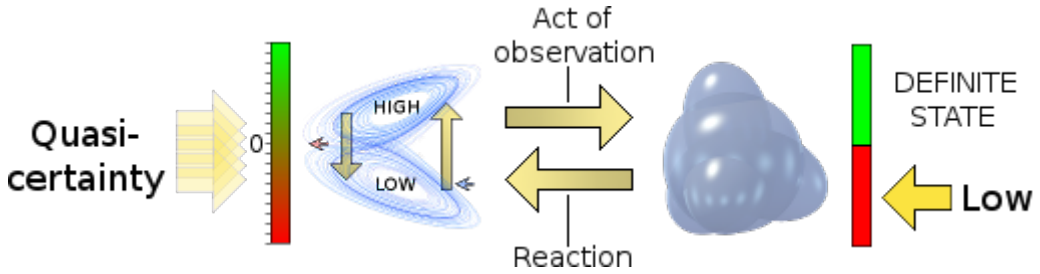
When the observer receives a message from the machine, he knows that the machine had to expend energy in order to send it. He can therefore reasonably speculate that the machine has a HIGH energy state from which to fall to a LOW energy state in order to liberate the energy necessary to send the message. The observer can therefore reasonably deduce that the machine has (at least) two finite states, even though he can never know when it is in its HIGH state and for how long it has been so.

Is the observer therefore justified in deducing further that, because he cannot perceive which state the machine is in at any given time, then it must be in both states at once? Does it make sense for him to assume that, unless or until he receives a message from it telling him it is in its LOW energy state, then it must necessarily be in a superposition of both its HIGH and LOW energy states?

I think not. Just because the actual state of the machine, at any given time, is fundamentally unknowable by an observer, does not mean that the machine itself, in reality, cannot be firmly in one or other of its mutually-exclusive states. Just because its state is indeterminable by an observer does not necessarily make it indefinite. The superposition of states exists not in what is being observed but within the *perceptual model* of what is being observed, as etched within the neural networks of the observer's brain.



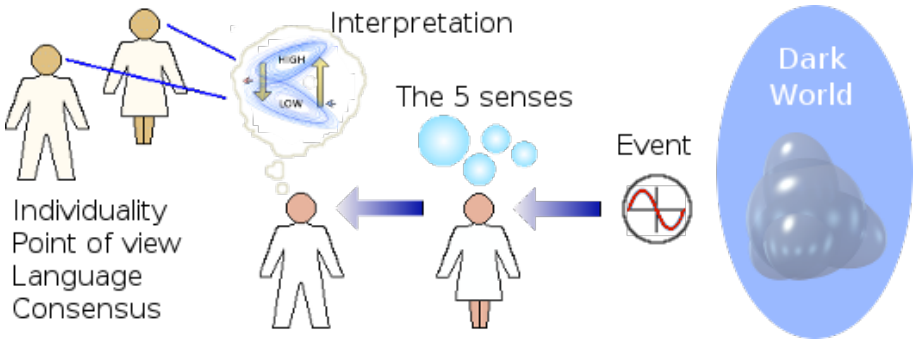
For the most part, the observer's conceptual model is completely isolated from the reality it represents. There is no physical connection between them. It is only in the event of the observer engaging in proactive observation that a fleeting connection is established. Even then, the connection is extremely tenuous and fraught with uncertainty. It is like trying to discern what somebody is shouting at you through a very long tunnel. Thus, although the machine may be signalling that it is in a definite state, the observer can have only a quasi-certainty of what state it is now in. Nevertheless, this uncertainty rests wholly within his perceptual model of what he is observing; not at all within the reality it represents.



The fundamental uncertainty in the observation comes not from within the machine itself. It is entirely due to inadequacies in the means through which the observer receives his information about the machine. It is due to a channel of perception which lacks the necessary and sufficient bandwidth

and diversity to convey to the observer all the detail he needs to make a complete and thorough observation of what he is looking at. After all, he can never see the *object* itself. All he is fundamentally able to observe is an *event* precipitated by the object's presumed spontaneous change of state from HIGH to LOW.

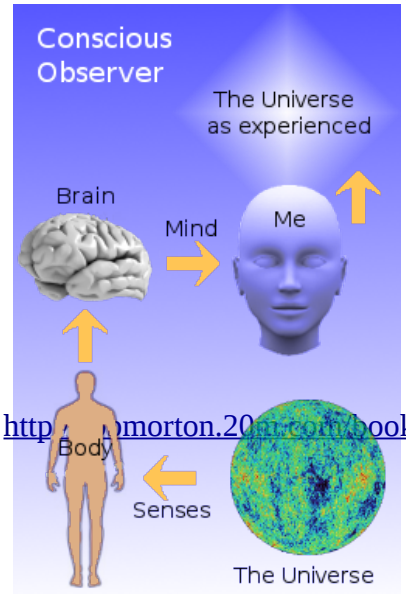
When viewing the macroscopic (or normal) world, I see it through my imperfect senses from what is, in most cases, a disadvantageous angle. What my senses give me, I then interpret against my incomplete and inadequate world-view given to me by experiences gained along my own limited path through space, time and the social order. Finally, I communicate my interpretation, through the chokingly narrow error-prone channel of natural language, to my peers, in order to arrive at some consensus view of what we each saw.



When viewing the microscopic (or so-called quantum) world, my frail human senses themselves cannot even see - or in any way sense directly - what I am looking at. The microscopic world is a dark world. It is illuminated by nothing. Even the instrument I use fundamentally cannot capture an image of what I am looking at. All it can relay to my senses is an event, which occurs when the thing I cannot see changes state. Even then, it does not emit an informative event for every type of change of state.

I think of it as watching a game of tennis where I can see the ball but not the players. My task is to observe the size, path, velocity and direction of the ball and thereby determine the structure, function and complete nature of the kind of beings playing the game. But it gets worse. I can only observe the ball when it accidentally hits me and thereby derive the size, path, velocity and direction of the ball from the impact. These difficulties are nothing to do with the nature of what I am looking at. They are due entirely to the enormous limitations of the only channel available to me through which I am able to look at it.

In all the foregoing, I have treated *what is being observed* as distinct and separate from *the channel* through which information about it is conveyed to the consciousness of the observer. But are they separate? No. By definition, the whole universe is a single integrated entity. Consequently, what is observed and the channel through which it is observed are all part of the same thing. So they cannot be separated physically. They can only be separated in my mind. So what made me consider them as separate?



From Where I am Looking

As an observer, my consciousness, like everybody else's, is trapped in its own singularity within the space-time continuum. It is a unique prison, which it shares with no other consciousness. This singularity is the apex - the oldest point - within my past event-horizon. Consequently, whatever I choose to observe, at any

other point, I can only view through a fallible chain of perception. My consciousness can never physically go there, however close it may be.

The universe bombards my physical senses with inputs. My body converts these inputs into nerve signals, which stimulate my brain. Within my brain, my mind interprets these signals in the context of its evolving neural model of the world outside. This invokes, within my consciousness, an experience of the physical universe.

Thus, the boundary between my conscious self and what I experience lies somewhere within my mind. As a conscious observer, my universe of experience must therefore include my body with its physical senses, my brain and my mind, which may be regarded as the software running within my brain. It is here that the *information interface*, between my conscious self and the external physical universe, resides.

Consequently, I must always regard my fallible chain of perception as an inseparable part of whatever I am observing.

On this basis, if I set up an experiment to observe a microscopic phenomenon, such as a particle, I must be aware that I am not, in reality, simply observing the behaviour of the particle. I am, instead, observing the behaviour of the particle, as modified, modulated and corrupted by that part of my observable universe which forms the chain of perception between the particle and my consciousness.

With My Mind's Eye

This is not, however, the way my conscious mind naturally views the world. On the contrary, it thinks it can transport itself to any location, within space and time, and attach itself directly to any phenomenon it desires to observe. If it wishes to observe the state of a particle, it just wraps itself around the space-time occupied by the particle and observes it from all directions at once. It thus tends to ignore the fact that it is trapped at the point-like apex of my physical event-horizon.

As a result, the focus of my interest, and therefore my attention, is the particle alone. I have no interest in - and consequently tend to ignore or forget - all the intervening space, instrumentation, physical senses and mental interpretation that lies between the particle and my consciousness. In my mind's eye, I see only the particle. And so when I observe my experiment, I tend to passively assume that it is only the particle itself that I am seeing.

In my mind's eye, I have an omnipotent view of all reality. I can see directly any thing in any place at any time from any angle. There is no intervening chain of perception distorting or corrupting my view. Thus, in my mind's eye, I see the particle in only one of its mutually-exclusive states. I see Schrödinger's cat as definitely either alive or dead.

This is because, in my mind's eye, I see what is intuitive. And this intuition is an accumulation of my life-long every-day experiences of how things look and behave in the macroscopic world. On the other hand, if I look at the particle with my physical eyes, I see it in a superposition of its two mutually-exclusive states.

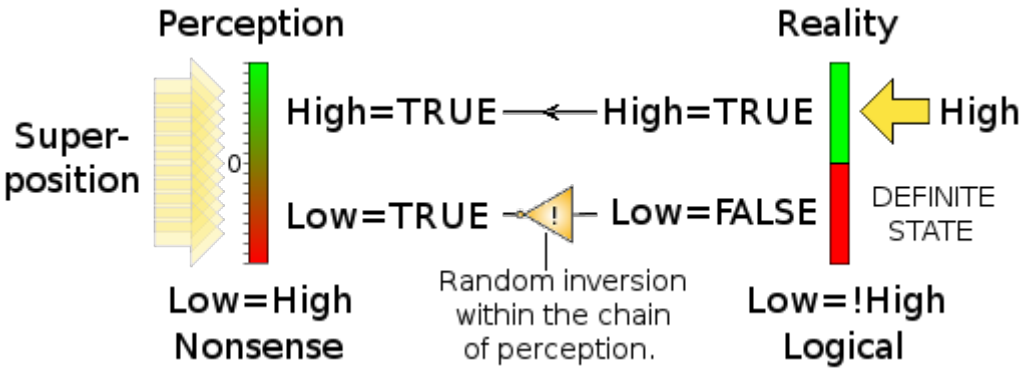
What I'm Really Seeing

But what I am looking at comprises not only the particle itself. It includes also the experimental apparatus, instrumentation, my eyes, my brain and the interpretive mechanisms within my mind. And this far more ample finite-state machine seems to exhibit the strange counter-intuitive behaviour we attribute to the quantum world. Like Schrödinger's cat, it has the ability to accommodate a superposition of two mutually-exclusive states-of-being.

In other words, I see Schrödinger's cat both alive and dead at the same time. By definition "alive" is "not dead" and "dead" is "not alive". If A="the cat is alive" and B="the cat is dead" then A=!B and B=!A. If A=!B then what is the meaning of A&B? Clearly A&B=Ø ("nonsense"). It has no meaning. Consequently, what I am seeing, through my physical eyes and the instruments that are monitoring my experiment, is nonsense.

It is well to note that nonsense is not merely counter-intuitive. Something that is behaving in a counter-intuitive manner is behaving in a way that is different from - but not necessarily incompatible with - all that has been previously experienced. A nonsense, on the other hand, is a behaviour which is wholly incompatible with all that has been previously experienced. The superposition of two mutually-exclusive states is a nonsense. But it is what I am seeing, through my instruments, from my experiment.

From this, I could conclude that the subatomic world is so strange that it is beyond human endeavour to make sense of it. On the other hand, I could suppose that perhaps the information I am receiving from the particle I am observing has somehow become distorted during its journey from the particle to my conscious view of it. Perhaps something along the path followed by the information randomly reverses its meaning. Sometimes it gets reversed, other times it doesn't.



This random inversion, within the chain of perception, could be a mechanism with a characteristic analogous to sideband dispersion, as experienced with long-distance radio transmissions in the short-wave bands. It distorts the signal, often to the extent of making it unintelligible.

My grandfather was a signaller during the First World War. Once, when he was short of wire, he rigged a signalling circuit using the River Euphrates as the return conductor. He often related the signaller's joke in which a signaller sent the message "Enemy advancing on west flank; please send reinforcements." The distortion was so bad over the signal path that the receiving operator heard, "Enemy dancing on wet planks; please send three and fourpence".

This emphasises the importance of considering a chain of perception's ability to distort, or otherwise modify, information emanating from what is being observed. Thus, my chain of perception, from

the particle to my consciousness, could be arbitrarily reversing the sense of some of the information it is conveying. It could even be accidentally picking up a statistical spread of indications from many particles. So these perfectly intuitive possibilities could easily turn a sensible original signal into nonsense.

Thus, as with our human perception of the macroscopic world, uncertainty in what we see of the microscopic world is likewise entirely due to the fallibility of our perception. There is no tangible reason to suppose that it be in any part due to counter-intuitive or nonsensical weirdness in the nature of what we are observing.

Which View is Relevant?

There exists an objective reality, which is both intuitive and sensible. I can see, with my mind's eye, an uninhibited view of this reality. But I can never see it, as it truly is, with my physical eyes. This is because its appearance, as presented to my consciousness, has necessarily passed through an intervening chain of perception, which distorts and corrupts what it passes. This applies on both the macroscopic and microscopic scales. On the latter, the distortion and corruption are so bad that the view conveyed is not only counter-intuitive but is also nonsensical.

But which view is relevant: the sensible objective view I see with my mind's eye, or the distorted and often nonsensical view I see with my physical eyes?

On the macroscopic scale, the two views are mostly reconcilable. I may see planets in the sky doing inexplicable epicycles. Nevertheless, within the context of my intuitive experience, it is not too difficult to transpose their motion, in my mind's eye, into a heliocentric view of simple orbits. Yet, if I think about it philosophically, the epicyclic view of planetary motion is every bit as valid as the heliocentric view of simple orbits. The only difference is in my position as an observer, which is nothing to do with the real structure and behaviour of what I am looking at.

On the microscopic scale, on the other hand, information is carried by perturbations within the fundamental force-fields. Consequently, the way I see the universe with my physical eyes is actually the way the universe is affecting me. In fact, it is what the universe *is* to me. On this scale, from the point of view of how the universe physically affects me, the objective view of my mind's eye is irrelevant. For me, it doesn't exist. Which of its two mutually-exclusive states a subatomic particle may be in is, and forever will be, unknown, unknowable and irrelevant. It can never directly affect me. What is real - what directly affects me - is what arrives at me. And that is a particle in a superposition of mutually-exclusive states. What arrives at me - what hits me - may be a nonsense. But in my universe - the universe that I experience - it is the unique and complete reality.

Fallibility of Thought

So far, I have only dealt, in any detail, with how information gets from the universe into the human mind. But how well does the mind interpret this information and thereby construct a conscious view of what has been observed? I have already mentioned how the mind uses natural language to construct a conscious view of what is observed. This conscious view is a working model of what is observed. But this working model is in no sense a comprehensive mental copy of anything in the outside world. It is merely a low-definition symbolic representation of it.

The elements of language - words and grammar - are not the same as the physical elements of the external universe, which they represent. They don't even share the same form or behaviour. The mental model of an observed phenomenon is simply a framework - a system of classification and

relation - by which the conscious mind tries to get some kind of perceptual handle on the external reality it represents.

The objects of thought, namely *words*, are not the objects to which they refer. They are merely labels: tenuous attempts to represent real objects symbolically. And the laws of thought, namely *grammar*, are not the laws which govern the physical universe. They are merely the linguistical rules which link words together into a semantic structure representing the apparent form and behaviour of the universe.

What About Mathematics?

But what about mathematics? Isn't mathematics the underlying fundament upon which the physical universe rests? Consider two established scientific observations:

> Newton's "law of acceleration": $F = M \times a$ and
> Newton's "law of gravity": $F = G \times M_1 \times M_2 \div r^2$.

Are these not solid objective realities? If so, then we can complete this notion by asserting that the mathematics of the Theory of Relativity be the underlying reality that becomes manifested to our physical senses as the material universe. Equally, however, we could make the same assertion about the mathematics of the Standard Model of Physics.

Notwithstanding, we know that, although the Theory of Relativity and the Standard Model of Physics are pretty good descriptions of different aspects of the physical universe, they are, nonetheless, mutually incompatible. How can two incompatible mathematical models *be* the real underlying fundament of a single universal reality? They can't. They are merely symbolic representations of our respective perceptions of our macroscopic and microscopic views of the universe. And a symbolic representation is merely a language.

The Theory of Relativity and the Standard Model are nothing more than essays, written in the *language* of mathematics, which are mankind's best macroscopic and microscopic perceptions of the real universe.

Mathematics is strictly a language. As such, it has existence exclusively within the perceptive mechanisms of the human mind. It is not a real underlying framework upon which the universe itself is built. It is merely a mental framework by which human consciousness tries to get a *handle of understanding* on the reality of the outside universe. The real underlying force which drives the universe, and the law which governs it, are something else. These are unknown to us and will most likely forever remain fundamentally unknowable.

Hierarchy of Operators

The universe does not contain hierarchies. It has - as far as it can be seen - what could better be described as a fractal nature. Hierarchies are structures of human language, used to categorise and classify what we observe, as an aid to making some sense of what we observe. Thus, mathematics has the structure and behaviour of a language: not of the physical universe it tries to describe.

Consider Newton's "law of acceleration": $F = M \times a$. It has letters which represent the values of three different measurable quantities. It then expresses an observed relationship between these by means of two symbols: = and ×, which represent the relational operators of equality and multiplication. Equality [=] is a fundamental operator. Multiplication [×], on the other hand, is a composite operator. It can be broken down into a component structure. It can be replaced by a more

complex expression using only the addition operator [+], which is more fundamental than the multiply operator [×]. An example of how this can be done is the following program snippet, which is in C-notation:

F = M; for(i = 0; i < a; i++) F += F;

Of course, this snippet, as it stands, only works if F, M and **a** are numeric integers: that is, whole numbers of *newtons*, *kilograms* and *metres per second per second*. Notwithstanding, each can be represented by a 64-bit register to whatever fractional precision may be required for a practical calculation. The upshot is that any human observation of an observed natural quantity [such as F, M or **a**] can only ever be expressed in terms of a radix-based system of numbering such as decimal, hexadecimal or binary. These can never express completely the continuously-variable values of the natural quantities which they attempt to represent.

I have already shown that even the more fundamental addition [+] operator is a composite of logical operations =, &, | and !, such that:

A + B ≡ Digit{(A | B) & (!A | !B)} Carry{A & B}

Thus, in the ultimate analysis, it would be possible to express any known Law of Physics in terms of the fundamental logical operators =, &, | and !, including all those involving multi-dimensional mathematical operators like grad, div and curl.

These fundamental logical operators, in terms of which all observed physical law can be expressed, are not the ultimate components of the real laws which govern the universe: they are the ultimate components of what George Boole called the Laws of Thought. They are the ultimate fundaments of language. And language has existence exclusively within the conscious mind. Consequently, although language enables the mind to discern the form and behaviour of the universe, it is not, in any sense, the framework of objects and rules upon which the universe itself is built and by which it is driven.

Logical Machines

What about logical machines: computers? These expedite processes, according to the laws of logic, independently of the human mind. They contain circuits comprising components which perform the logical operations &, | and !. These, in turn, execute programs, which comprise sequences of logical imperatives written as statements of a programming language such as 'C'. Doesn't this behaviour of a mindless machine, constructed entirely of physical material, evince the presence of the Laws of Logic within the material universe?

The materials, of which the most basic components of a computer - its transistors, capacitors and resistors - are made, behave according to the real laws of the physical universe. By observation, science has abstracted and expressed in the language of mathematics, the observed laws and properties which these materials exhibit. Engineers have then used these observed laws and properties to design an order in which to put these materials together to build the transistors, capacitors and resistors with which to construct a computer.

Others then assemble these components into circuits which *they design* to perform logical operations *in the same way* as those logical operations are reasoned within the human mind. Thus, the *logical functionality* of a computer does not come from the observed laws of physics. It comes from the observed laws of thought. And it is put into the computer's circuits by engineers: not by nature.

The materials, of which the transistors, capacitors and resistors are made, could be thought of as bricks. They behave according to the observed laws of physics. The logical functionality of the computer, on the other hand, is a palace built of bricks. The design of the palace is much more than the design of its bricks. The design of the palace came from the mind of the architect: not from the bricks. Another useful analogy is pen and paper. The laws of thought, by which the meaning conveyed by words written on a piece of paper are encoded, are nothing to do with the laws which regulate the physical and chemical composition of the paper or the ink, nor even with the laws that govern the mechanics of writing.

Abstract Identities

The languages of Logic and Mathematics are only known to exist within the human mind. They have no tangible counterparts in the outside universe. But can - do - mathematics and logic contain entities that are inherently self-existent: that exist within the human mind but independently of it? What about such things as Euler's Identity?

$$e^{i\pi} + 1 \equiv 0$$

This is a grid-locked relationship between what are called *universal constants*. Two of these constants are the integers 0 and 1 - the only two mutually exclusive values which a logical variable may have. The constants **e** and **π** are transcendental numbers, which can never be represented exactly by any numbering system based on an integral radix such as 2, 8, 10, 12, 16. And $i = \sqrt{(-1)}$, a number so bizarre that mathematicians call it "imaginary". Yet these five unlikely bedfellows form the above immutable relationship, which seems to relate logic with multi-dimensional dynamic geometry.

Euler's Identity is not a convention agreed by mathematicians. It just is. As such, it appears to have an existence in its own right. But is it representing something that exists in the physical universe? Or does it merely exist as a semantic construct entirely within the human mind? To answer this question, we must examine its components.

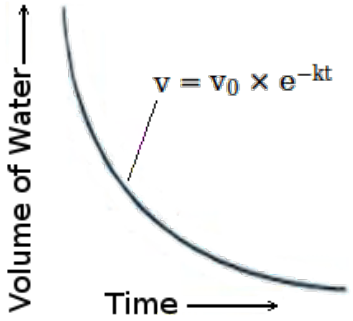
The Exponential Constant e

e≈2·71828 is known as the exponential constant. Consider an object that is continuously shrinking. The rate at which the object is shrinking, at any given instant, is proportional to its volume, at that instant. Its rate of change of volume: $(dv/dt) = -kv$: its current volume **v** times a constant of proportionality **k**, which is called the object's rate of shrinkage. To calculate what its volume will be, after any given lapse of time after you started to observe it, you need to "solve" the differential equation $(dv/dt) = -kv$ for the amount **t** of time that has elapsed. The mathematical "solution" is shown below.

The original differential equation:	$(dv/dt) = -kv$
Divide both sides by v and multiply by dt:	$(1/v)dv = -kdt$
Integrate both sides of the equation:	$\int(1/v)dv = -k\int dt$
Result of integration: [ln=logarithm to base 'e']	$\ln\|v\| = -kt + c$
Make both sides of the equation powers of 'e':	$e^{\ln\|v\|} = e^{-kt+c}$
e to the power ln(number) is simply the number:	$\|v\| = e^{-kt} \times e^{c}$
e to the power of a constant is another constant,	so let $C = e^{c}$

So the volume of the shrinking object at any time t:	$v = C \times e^{-kt}$
Evaluate this expression for when t = 0:	$v_0 = C \times e^{-k0}$
Any number raised to the power of zero = 1	$v_0 = C \times e^{0}$
So C is simply the initial volume when t = 0	$v_0 = C \times 1$
So the volume of the shrinking object at any time t:	$v = v_0 \times e^{-kt}$

A practical example of a "shrinking object", in the above context, is water flowing out of a barrel. There is an open tap in the side of the barrel near the bottom. Water is emptying out of the barrel through the tap. The rate at which the water flows through the tap, at any given instant, is proportional to the pressure pushing the water through it. This, in turn, is proportional to the head of water above the tap at that instant, which, in turn, is proportional to the volume of water left in the barrel, at that instant.



From the above analysis, it is easy, at first sight, to suppose that the transcendental constant **e** plays some fundamental role in the dynamic process of a shrinking object whose rate of shrinkage, at any given instant, is proportional to its actual volume at that instant. In other words, it would appear to underpin the real-world mechanism that conducts the shrinking process. But it doesn't.

The universe is not a static object. Neither is it a series of static frames like a movie. It can only exist in a dynamic state. It is a continuous on-going event. You cannot freeze-frame the universe, or indeed, any part of it. Time is a flow. It cannot be stopped. So-called "points in time" are a construct of human consciousness. We can conceive of them only because we possess the faculty of memory from which we can consciously recall semantic representations of past events.

Consequently, the notion of an *amount* or *lapse* of time - a number of seconds, minutes or hours - exists only within the human mind. A standard time reference, such as Greenwich Mean Time [GMT], is even more a notion that can exist only within the human mind. The universe makes no reference to GMT or any other artificial time standard. Such standards, or systems of reference, measure what is conceptually a "distance" through time. It is this "distance" that is measured in seconds, minutes and hours: not time itself. This is because the reality of time is a rate of flow. It is a universal rate at which we pass through seconds, minutes and hours. And this rate of flow cannot be measured against anything because it is the most fundamental property of the real universe. It is the ruler against which everything else must be measured.

The upshot is that the so-called "solution" to the differential equation $(dv/dt)=-kv$ is not the fundament. The dynamic process represented by the differential equation is the fundament here. The so-called "solution" $v=v_0e^{-kt}$ is a notion which exists only within the human mind, as a result of its possessing the faculty of memory with which to recall what the situation was like at various "points" in the past. And these "points" are nothing more than snap-shots stored in the memory as the real time in the outside universe relentlessly flows onwards at its immutable rate.

The differential equation $(dv/dt)=-kv$ is, an albeit imperfect, representation of what is taking place in the real universe. Its solution $v=v_0e^{-kt}$ shows a view in which time is frozen: a thing which, in reality, cannot exist: a thing which can only be constructed within the human mind by virtue of

human memory. The constant **e** is a component of the "solution" and not of the "problem". Consequently, **e** pertains not to the real world but to how the human mind perceives the real world. It is a natural universal constant relating to the mechanism by which the human mind tries to get a handle of understanding on what is taking place in the real world.

It appears that the human mind is best able to perceive a dynamic real-world phenomenon as a static representation, comprising a series of freeze-frame views extending over a prescribed period. In other words, as a time-graph in which, what is perceived as an *extent* of time, is *represented* by a physical distance on a piece of paper or monitor screen. Such a static representation is therefore nothing more than a mental template against which the human mind is able to recognise the phenomenon.

Representation, in this form, of a natural phenomena in which the rate of change of something is proportional to the current instant magnitude of that something, is a curved time-graph $x = x_0 \times e^{-kt}$, where $\mathbf{x_0}$ and **x** are the initial and current magnitudes of that something, **t** is the amount of time that has elapsed since observation of the phenomenon began, **k** is a constant of proportionality and **e** is the transcendental constant.

Notwithstanding, you cannot, in reality, stop the flow of time. Time *is* a flow. All natural phenomena are, however still they may appear, dynamic. They all involve continuous motion of some kind. Consequently, the real mechanism of nature, which is driving what we are observing, is very simple. It can be more truly represented by the equation: $x' = -k \times x$, where **x'** represents the rate at which **x** is changing and **k** is a simple constant of proportionality. No mysterious transcendental number is involved in the real-world phenomenon.

The transcendental constant **e** is thus part of the grammar of the symbolic language of mathematics, through which we try to get a perceptual handle on certain phenomena we observe in the outside universe. As such, it has real existence and significance exclusively within the human mind.

But what about the dynamic representation of the phenomenon: $x' = -k \times x$. Is this the law that underlies the reality? Not exactly. It gives us a statistical view - an overall view - of what appears to be happening. As such, it is much more a representation of the real universe than the time-graph equation. But this does not mean that this mathematical representation is the underlying motivator of the real phenomenon.

The reality of a phenomenon comprises interactions between nanoscopic entities on a nanoscopic scale. Each such entity interacts with each of its neighbours according to a particular protocol. This protocol could be simple. Or it could be an interaction of complex-dynamical states. Nobody really knows. However, the result of all these zillions of interactions, between zillions of nanoscopic entities, gives macroscopic beings like us a macroscopic view we see as representable by the equation $x' = -k \times x$. But the idea that this equation represents what nature is really doing is an illusion. It too is a mere template, which the human mind sees at fitting snugly around the large-scale effect of a real but unknown relational protocol operating on the nanoscopic scale.

According to what is considered to be pure mathematics, the solution to the differential equation $x' = -k \times x$, namely, $x = x_0 \times e^{-kt}$ is arrived at by considering an infinite number of infinitesimal advances in time. This is considered by many to be the ultimate purity of what is really driving the universe. Notwithstanding, it is evident that, at least in the case of the water emptying from the barrel mentioned above, the real mechanism involves zillions of *discrete* encounters between *finite* water molecules. Consequently, the reality cannot be the infinitely smooth continuum depicted by

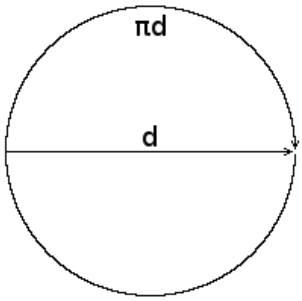
the mathematical solution $x = x_0 \times e^{-kt}$. It's much more like the iterative jumps of the *numerical methods* for solving differential equations.

Solutions to differential equations, which involve transcendental numbers and continuous functions, are considered to be the pure and beautiful work of mathematicians, which show us how nature really works. Numerical solutions, on the other hand, are considered to be crude "suck it and see" methods used principally by engineers for getting approximate solutions for designing their machines, systems and devices. To my mind, these ideas are the very opposite of the truth.

The beautiful solutions of the mathematicians apply to only a very few special cases. The vast majority of differential equations that represent the behaviours of natural phenomena can only be "solved" by numerical methods anyway. But all cases are equally real. The only generic methods for solving differential equations are therefore necessarily numerical. The key to accuracy is not to use the continua of pure mathematics but to use iterative steps which are as small as the ones nature uses. Of course, for some phenomena, this might involve using steps in time and space as small as the Planck intervals. And this is problematic.

Notwithstanding, whatever mathematical methods are employed, they are all mere templates, used by the human mind, to try to make sense of what we see; to try to classify or categorise our observations. It's just that the "crude" numerical methods are a bit closer to the way nature actually creates what we see.

The Circular Constant π



A circle is a mental concept. It is constructed, mentally, by moving a fixed-length radial angularly through a complete turn within a fixed plane. The ratio between the distance round this mental construction [its circumference] and the distance across it [its diameter] is a transcendental number which mathematicians represent by the Greek letter π. Although π has an approximate numerical magnitude of 3·141592653, its true magnitude, fundamentally, can never be computed exactly in any numbering system with an integral radix.

As a component of the human language of mathematics, π indisputably exists. As such, it can be used, quite effectively, to refer to certain aspects of the shapes of real objects in the outside universe. Thereby we can perceive that many objects in the universe - such as stars, planets and orbits - have a tenancy towards roundness. To a somewhat lesser extent, so do objects on Earth, such as trees and flowers.

Notwithstanding, nature does not construct circles - either absolute or approximate - by rotating fixed-length radials through complete turns within fixed planes. On the contrary, nature constructs what we perceive, on the macroscopic scale, as circular characteristics or roundness through what I would call *fractal* laws or protocols operating - bit by bit - on a nanoscopic scale.

The real laws of nature, which govern the motion of a planet moving in a circular orbit, are unaware of the concept of a circle. Nature does not consider a circular orbit to be any more significant than an elliptical, parabolical, hyperbolical or rosette-shaped orbit. Indeed, these are all special cases of the mathematically inexpressible meandering orbits encountered in the so-called *many body problem* of a star wandering through a well populated galaxy.

As far as nature is concerned, a body's path through space is determined entirely by local irregularities in the aetherial flux within the space through which it is passing. Large scale special case notions like circles, ellipses, parabolas, hyperbolas and rosettes, are mere geometrical templates used by the human mind to try to differentiate between variants of the general case.

Space Within The Mind

These templates are, for most people, based on Euclidean geometry. Euclidean space is a mental frame of reference. And a frame of reference must have an origin, which is the coincident zero-point of the three mutually perpendicular axes. Every place in Euclidean space is defined in terms of its relationship to [distance and direction from] an origin. An origin is thus a favoured point in Euclidean space. It is where the observer is located. It is the point at which his consciousness is seated: his point of view. So Euclidean space is space which occupies an observer-centred frame. But it is not real space: it is imaginary space, which helps an observer to create a *perception* of real space.

Within the Euclidean space of his imagination, an observer can construct abstract geometrical objects like lines, circles, ellipses, parabolæ, hyperbolæ, spheres, tetrahedrons, cubes, dodecahedrons and various hybrids of these. He is able to view, scale, translate and rotate them within his mind and thereby use them as gauges to categorise by shape whatever he sees within the outside universe. These geometrical structures are what may be regarded as complex nouns or substantives of the geometrical subset of the language of thought.

These somewhat *analogical* substantives can be represented or symbolised by the language of mathematics. Lines, circles, ellipses, parabolæ, hyperbolæ, spheres, etc. can be represented, within a Euclidean frame of reference, by mathematical formulæ comprising symbolic constants, variables and operators. And π is one of those constants. As such, it pertains to the Euclidean space of the imagination: not to the real space of the real universe. Thus, it is not a property of real space: it is part of an imperfect language in which an observer *thinks about* real space.

Here within the Earth's biosphere - the environment within which the human mind was developed - the plane and 3-dimensional geometries of Euclid provide a good set of perceptual templates against which to measure and make sense of what we see. But once we look outwards to the stars, it doesn't seem to work quite so well. A more sophisticated template is required.

The relativistic space-time of Einstein provides a more sophisticated template for the vast scales of the stars and galaxies. The geometries of Quantum Mechanics provide a more sophisticated template for the nanoscopic scales of atoms and fundamental particles. Yet neither of these is perfect and they are themselves mutually incompatible. So they cannot be reality. Neither can they represent reality absolutely.

Real space-time, whatever it may be, is not Euclidean. Neither is it Einsteinian nor is it Bohrian. All these are instruments of human perception which exist solely within the human mind. The only way we can even express or conceptualise Einsteinian or Bohrian space-time is in terms of our crude Euclidean concepts of space and time. The mathematical constructs of Einsteinian and Bohrian space-time are built of Euclidean conceptual components. The so-called *natural constant* π is one of these. It is a constant of Euclidean space, which is a thing of the mind; not of the objective reality that is thought to lie beyond the mind in the external universe. Thus π cannot be other than an element of the laws of thought.

The circle - and the relationship between its diameter and circumference, π - are very special to Euclidean space. Notwithstanding, the circle is neither here nor there in real space-time. A planet

moves in relation to a star in what our minds can only conceptualise as an infinitely fine incremental fashion with the flow of time. The shape of what we perceive as a complete orbit is irrelevant. The chance of it being circular is almost zero. Even the chance of it being elliptical, parabolic, hyperbolic or even rosette shaped is pretty well equally remote. Any orbit is, in reality, always irregular and meandering: never closed. None of these conceptual geometrical shapes even so much as forms a dynamic attractor for an orbit. Thus π has no part in external reality. It is a property of the way we think and imagine.

The Complex Operator i = √(−1)

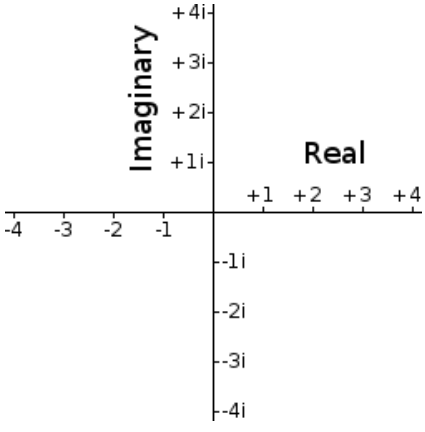
The square of *plus one* is *plus one*: $(+1)^2 = +1$. So, conversely, the square root of *plus one* is *plus one*: $\sqrt{(+1)} = +1$. But the square of *minus one* is also *plus one*: $(-1)^2 = +1$. So what, when squared, gives *minus one*? In other words, what is the square root of *minus one*? It can be neither *minus one* nor *plus one*. Of course *minus one* × *plus one* gives *minus one*: $(-1) \times (+1) = -1$. But *minus one* does not equal *plus one*: $(-1) \neq (+1)$. Consequently, neither can be the square root of −1. So the square root of *minus one* would appear to be an arithmetical paradox.

> NOTE: The cause of this paradox is the arbitrary human convention that, while negating a positive produces a negative: $-(+1) = -1$, positivising a negative does not produce a positive: $+(-1) \neq +1$. Thus positive and negative numbers are not logically symmetrical. And an arbitrary human convention is a thing of the mind: not of objective reality.

A clue to the meaning of the square root of *minus one* is in the fact that it gives the same arithmetical result as *minus one* × *plus one*: $\{\sqrt{(-1)}\}^2 \equiv (-1) \times (+1)$. This suggests that, conceptually, it is mid-way between *minus one* and *plus one*. On a scale of pure numbers, that would make it zero. But zero × zero does not give −1. So √(−1) must be mid-way between +1 and −1 in some other sense.

However, as well as being mid-way between +1 and −1 in some sense or another, √(−1), by reason that it produces a result of unit magnitude, must itself have unit magnitude. In other words, although its magnitude be neither +1 nor −1, its magnitude must - in some other peculiar sense - be 1. But how can this be? How can a number be half-way between +1 and −1 and also have unit magnitude?

If √(−1) indeed be mid-way between +1 and −1, it must have a zero magnitude on the scale of real numbers. Notwithstanding, it could have any finite magnitude along any dimension perpendicular to the scale of real numbers. Consequently, we may conceive of √(−1) as having a unit magnitude on a scale of *imaginary* numbers that extends along any dimension that is perpendicular to that containing the scale of real numbers. Since this scale of *imaginary* numbers be perpendicular to the scale of real numbers, it follows that the magnitude of an *imaginary* number must be independent of magnitudes along the dimension containing the scale of real numbers.

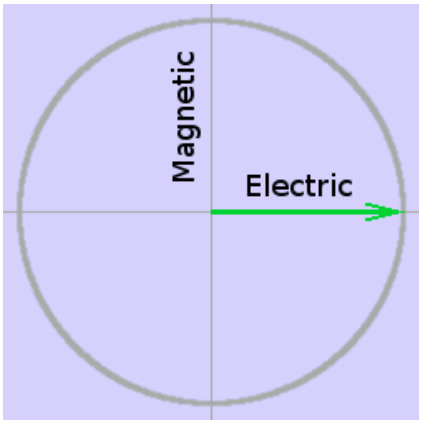


Mathematicians represent √(−1) by the letter 'i'. Electrical engineers represent √(−1) by the letter 'j'. Thus $i^2 = -1$. So 'i' can be conceived as a unit distance along an imaginary dimension (or line) which progresses at right-angles to the linear dimension (or line) along which we represent real numbers in terms of unit distances.

I have already considered −1 × +1 = −1. Now, what about −i × +i? Well, this is the same as (−1) × i × (+1) × i = (−1) × (+1) × i^2 = (−1) × (+1) × (−1) = +1. It would thus seem that multiplying a number by +i has the effect of turning it through a right-angle in a clockwise sense, while multiplying a number by −i has the effect of turning it through a right-angle in a anti-clockwise sense. Multiplying a number by +i twice effectively turns it through 180°, which is the same as reversing its sign.

Multiplying any number by 'i' does not alter the magnitude of the number. Instead, it changes the the number's dimensional or geometrical relationship to other numbers or magnitudes. Consequently, rather than thinking of 'i' as a number, mathematicians tend to classify it as a mathematical operator like + − × ÷. This complex operator is used a lot in mathematics, science and engineering, especially to represent the dynamic relationships between parameters such as voltage and current in both power and radio frequency devices.

But does this mean that 'i' is real? Is it a fundamental element of the external objective reality we refer to as the universe? Or are imaginary numbers also a figment of human imagination?



Perhaps the most practical use of the complex operator is in the graphical representation of relationships between the alternating currents and voltages in reactive electrical circuits and the electric and magnetic vectors of waves propagating through space-time. The adjacent animation shows the dynamic relationship between the electric and magnetic field vectors of an electromagnetic wave as it passes an observer on its journey through space. One could re-label the axes *Electric* and *Magnetic* to represent the dynamic relationship between the voltage and current in an electrical circuit containing capacitors and inductors.

Such relationships are dynamic. The phenomena only exist within space *and* time. If you could, in reality, freeze-frame such a phenomenon, it would collapse instantly into nothing.

Of course, you can draw a static graph showing a freeze-frame representation of the phenomenon at any arbitrary "point in time". Notwithstanding, such a static representation is solely for the purpose of helping the human mind to get a handle on a difficult-to-grasp dynamic phenomenon. But this kind of representation is an entirely artificial notion. It represents a situation that cannot exist in reality.

The complex operator 'i' [or 'j' for electrical engineers] is part of a symbolic means of representing both dynamic animations and static snap-shots of these phenomena algebraically on paper. As such, it is part of a mathematical language used by the human mind to express and manipulate human perceptions of these natural phenomena. Thus 'i' too is a thing of the mind: a participant in the laws of thought. It is not an element of an implied external objective reality we call the universe.

Euler's Identity: $e^{i\pi} + 1 \equiv 0$

This interlocking relationship between the logical integers '0' and '1' and the so-called natural constants 'e', 'π' and 'i' appears, at first sight, to have tangible existence within the implied objective external reality we call the universe. Notwithstanding, I have shown above that its component elements are all merely part of a linguistic template by which the human mind enables the conscious 'self' to get a handle on that implied objective external reality we call the universe.

And if this be so regarding Euler's identity, then it is probably true of the more complex and sophisticated objects which exist within the universe of mathematics such as the beautiful and extensive Monsters of Symmetry.

The universe itself works according to its own rules, which, to us, are largely unknown and which are perhaps even unknowable by virtue of the fact that the human mind is simply not capable of perceiving them as they really are. This is probably because the human mind was - at least from a physical point of view - developed to guide us through our natural environment of the Earth's biosphere, which it does very well. The mystery remains, however, as to how and why the human mind is capable of imagining worlds that are beyond the bounds of observed reality - worlds of fantasy, mystery and disembodied conscious existence.

There are unlimited ways in which the human mind may attempt to gain a cogent view of the reality within which it has being. I have written about two personal views of the universe: here and here. Notwithstanding, these views are mutually incompatible and internally inconsistent. But this is inevitable and is no cause for shame. Human perception is fallible. Consequently, one can never expect it to be consistent. The virtue is in experimenting with perception, not in perfecting it.

Conclusion

Human perception is fallible. The view of any observer can only be from one point in space at any given time. His bodily senses - and any instruments he may use to extend their reach - corrupt and distort the information they convey. The mechanisms of thought, whereby he attempts to understand what his senses deliver, give different mutually inconsistent interpretations at different angles and scales. His emotions and memories further warp and embellish the view he perceives.

But is this bad? I think not. I believe that, if scientists were ever to discover the fundamental bedrock of the universe, they would find it supremely bland and boring. Notwithstanding, it provides two things that are vital to mankind: 1) the framework upon which he builds his perceptions of reality; 2) the medium through which he may discuss his perceptions of reality with others.

The objective reality of the universe is thus not the end in itself. It is merely the agent that provides the conscious self with the stimulus necessary to construct embellished perceptions of what is out there: to construct imaginary objects and views of significance and beauty, which are above and beyond their objective reality.

An example of this phenomenon used to occur along the old tow path by the side of the River Stort in England. Within the largely grassy flood plain was a small coppice of willow trees. As I approached the coppice on a warm sunny afternoon, I reached a point on the path at which, for me, the scene turned magical. The swish of the wind through the grass and the willow leaves. The textures of the tree trunks. The swaying of the branches. I felt that I was in an enchanted wood. It seemed to be aware of me. I was ensconced in another dimension, far far away from the red-bricked suburbia from which I had come.

But this sensation only lasted over a short 3 to 5 metre stretch of the path, just before entering the wooded area. Before or after this short stretch of path, I was just on a flood-plain close to a clump of soulless trees. They were the objective reality. My enchanted coppice was a product of my perception, created by my conscious mind, embellished by my memories.

Each observer's perception, of the same objective reality, is necessarily different from everybody else's. And these differences provide a motive for discussion. Discussion develops relationship.

Thus it would appear that nature's ultimate objective is to facilitate the development of relationships between human beings. And for this to work, it is essential that human perception be fallible.
