"Wandering towards a 'Theory of Everything' and how I was stopped from achieving my goal by Nature" by Lachlan Cresswell.

Abstract
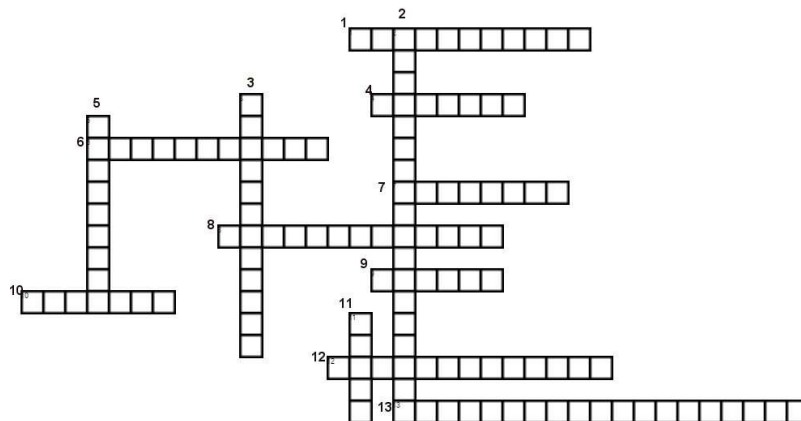
ACROSS

1 A philosophical belief that all events are determined completely by previously existing causes.
4 The author of 'A New Kind of Science'.
6 A decision problem for which it is proved to be impossible to construct an algorithm that always leads to a correct yes-or-no answer.
7 The ability to choose between different possible courses of action unimpeded.
8 A universe where past, present and future hold equal supremacy.

9 Point particles in particle physics, conceived of as sub-components of quarks, and leptons. The word was coined by Jogesh Pati and Abdus Salam, in 1974.
10 A French mathematician.
12 A mathematical model of computation that defines an abstract machine, which manipulates symbols on a strip of tape according to a table of rules.
13 A conjecture that every even number greater than two is equal to the sum of two prime numbers.

DOWN

2 A hypothetical framework explaining all known physical phenomena in the universe.
3 1.6E-35 metres.
5 Austrian logician and mathematician who was a friend of Einstein.
11 Old Norse Norn of the future.

A wander down memory lane, from when I first encountered Goldbach's Conjecture and my foolhardy attempt to prove it, to my exposition on time and free will. I explore the ancient texts of Snorri Sturluson's Prose Edda to learn of new cosmogonies. I attempt to develop a 'Theory of Everything', get close and get excited, but eventually I realise that, due to uncomputability, my goal is stymied by Nature. With the help of two demons I examine determinism and wave/particle duality, and decide that Maxwell rules!

Undecidability

About forty years ago I read about Goldbach's Conjecture[1] (GC) in a philosophy book. The conjecture can be stated thus: "Every even number greater than two can be expressed as the sum of two prime numbers". I was immediately drawn to exploring the conjecture and what I achieved, after a few false starts, was an identity that although not proving the conjecture, showed me that the conjecture could not be disproved. Not being formally trained in mathematics I did not understand the significance of what I had done until many years later, when a mathematician friend explained that a disproof was also very important

in maths. I went looking for my lost proof but, alas, I could not resurrect the logic despite several attempts.

If I was right and GC could not be disproved that meant that no contradiction could be found and that a Universal Turing Machine[2] (UTM) running a GC checking program would never halt[3], and thus could not be used to successfully verify the conjecture. In other words, a disproof of the conjecture would show that GC is in the class of conjectures that are undecidable.

Uncomputability

Eighteen years ago, while reading "Superforce" by Paul Davies I discovered a typo that lead me on a twenty minute reverie pondering the charge and spin of fundamental particles. When I had concluded my thoughts I realised that I had uncovered a fundamental difference between protons and neutrons, that gave great insight with respect to particle interactions. I tested my new found discovery on many particle interactions using the Fermilab website, and found a few instances of interactions that I believed were in error. I emailed Fermilab the suspect interactions and my corrections, and they replied the next day thanking me for correcting errors in their particle interaction webpage.

This morale boost prompted me to think deeper on the matter of preon theories, and after many years of analysis I have been able to successfully reduce all physical processes to two particles, a matter particle and a force particle, and a set of simple interactions between them. I call my Theory of Everything (TOE) 'Ginnungagap' theory after the Old Norse for the primaeval void[5].

I thought deeply on my TOE and realised that this theory could not be represented algorithmically with my model, but that a 3-D cellular automata approach might work. I ended up with just over a dozen simple rules that could be easily implemented on a computer, or so I thought. But when I calculated the memory requirements to hold my simple model at the Planck scale, I realised that if I used all the particles in the Universe (10^{80}), using better than the current 20 nm^3 lithography memory cell for my basic 'finite state machine' I would only be able to model a real volume of about 5 cubic microns, using an ideal UTM computer. Thus I realised that my TOE was practically and practicably uncomputable!

In my explorations of what is "practicably' computable I learnt that some simple rules using recursive enumeration in cellular automata can, depending on the initial conditions, readily lead to emergent and complex evolution, sometimes showing undecidability. Some readers may be familiar with Stephen Wolfram's book 'A New Kind of Science', in which Wolfram gives examples based on a 4-color totalistic rule with code 1004600, and concludes that " in general there appears to be no finite computation that can guarantee to determine the final outcome of the evolution after an infinite number of steps". This means the question of the evolution of the system is formally undecidable despite being computable, as I showed with the previous example of GC.

Determinism and unpredictability

Now I want to consider determinism, the philosophical belief that all events are determined by previously existing causes. This idea can be traced back to Laplace's demon, published in an essay in 1814 by Pierre Simon Laplace. Laplace said *"We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes."*

Laplace's thought experiment can be easily criticised for its flaws, such as how would such vast information be collected instantaneously and how would it be stored and processed (similar to my previously mentioned 3-D cellular automata TOE). Another flaw, brought to the surface by Einstein's Special Relativity (SR), is the notion of simultaneity. In other words how can the demon collect all the required information 'at a certain moment'?, as SR eliminates a universal present across all of space.

However, if the demon could invoke an identical parallel universe, run slightly ahead in time of our universe might we not be able to use it to predict the future? This type of thinking leads to the notion of pre-determinism, the idea that all events are determined in advance, implying a chain of prior occurrences going back to the origin of our universe, and similarly going forward in time, leading to the idea of a block universe, where past and future hold equal supremacy with the present. I, however, believe that our demon's two universes will run identically until the first example of a conscious entity arose in both, at which time the free will of the entity will cause the two universes to diverge in their respective evolutions. (I will discuss free will and skuld[6] behaviour in a later section of this essay).

Thus this argument invoking free will makes the evolution of our universe also formally undecidable, hence the holy grail of a computational TOE can never be achieved.

Quantum Uncertainty and the demons of Maxwell and Laplace

The classical view as expressed by Laplace above, was that the future motion of all particles was completely determined if positions and velocities (forces) at one time. However the quantum view had to be modified in light of Heisenberg's Uncertainty Principle, which said that we can only know a combination of position and momentum, as given by the wave function. Thus, instead of being able to predict the position and speeds of all particles, we have given Laplace's demon the ability only to predict the wave function.

The quantum view also limits us in other ways as well. Take for example Loschmidt's paradox, which suggests that it is not possible to deduce an irreversible process from the time-reversible laws of classical mechanics. In 1876, Loschmidt, who was a friend of Boltzmann, pointed out that if one studies the motion of a system of gas over a period of time that leads to an increase in entropy, then there must be an allowed state of the same

system, found by reversing all the velocities of the gas molecules, in which the entropy will decrease, thus breaking the second law of thermodynamics. Indeed Maxwell arrived at a similar position in 1867 with his thought experiment invoking a demon controlling a door between two chambers of gas, choosing which gas molecules can travel from one chamber to the other in order to violate the second law. Loschmidt's paradox is thus asking the questions "What breaks the time-reversibility of classical mechanics? Or How is it possible to have a thermodynamic arrow of time?"

I have found an answer to this question that clashes with quantum mechanics. The answer lies in the notion that wave/particle duality is an incorrect concept. The reasoning is as follows: All charged particles (ie. all particles of matter, as neutral particles are constructed of charged particles) emit electromagnetic radiation when accelerated. If this radiation is in the form of Einsteinian photon particles then the time-reversal laws of physics will hold. However, if we consider this radiation to be in the form of Maxwellian waves then time-reversal should not apply as Maxwellian waves are always seen to be divergent in nature, not equally convergent as would be required if time-reversal laws held. Thus Maxwell's demon simply would have required convergent waves to be able to violate the second law. As this is not the case then I suggest that wave-particle duality is implausible, making determinism impossible, if one believes in Maxwell.

Presentism/Verdandism

But enough of demons! I want to further discuss determinism from the point of view that only present things exist. This philosophy is called presentism. What we mean by present is "the Now". My definition of duration favours presentism of the form "Only present things exist and what is present changes". That is to say, by definition, only dynamical energy in the "Now" (present) can be considered to exist.

Past and future are presently only constructs of biological systems, from viruses to humans, and only exist as symbolic maps (image realities) of a variety of types, in the "Now". Examples of the past could be the digital arrangement of ones and zeros that are found in a photograph stored on a USB memory stick, or a memory or thought encoded in the biochemistry of my brain, or the arrangement of DNA stored in a plant seed, to the layers of a sedimentary rock being considered by a geologist.

Take for example my love for my dead father. My love is an emotion in the now, based on chemical reactions in my brain, regarding memories of my father which are also stored in my brain, possibly in conjunction with a photo of my father (or some other facsimile such as a video or a sculpture) that elicits some further emotion in my brain. Ultimately all of this can be reduced to causal relations between energy forms in my brain in the Now.

Included in our maps are all the creations of skuld[6] organisms such as the realm of mathematics or anything else that is contained in living memory, or preserved in any other form of memory such as a book. Once the 'memory' is lost it no longer exists in the now. It may be re-invented in the future or may remain lost for all eternity (never returning to the now).

Ultimately my form of presentism is that only energy in space exists. "Relative Presentism" is my claim that energy in one defined space exists relative to energy in another defined space with dynamical force laws that describe the relative motion of both the energy forms. In keeping with my practice of using Old Norse naming, I suggest that relative presentism be known as Relative Verdandism[7] (RV). As previously mentioned SR eliminates absolute simultaneity so it eliminates a universal present across all space, thus I believe forcing one to a position of accepting relative presentism. General Relativity (GR), as defined by Einstein, is compatible with relative presentism, as GR considers how both energy and momentum (mass times velocity) warp space-time. RV can be seen as a universe of three-dimensional space modulated by the movement (change) of the energy contained within. Note that General Relativity and Relative Verdandism are theories that do not require 'observers', unlike Special Relativity which requires observers with clocks and rulers. Cross-temporal relations do not pose an issue as I have allowed the physical (electric, magnetic and gravitational) force laws of to act between disparate energy forms in space so that causal relations still hold. (This is a very complex matter that is outside the topic, hence I will not try to explain it in this essay).

By way of contrast, Externalism is another philosophical approach to time, in which existence in past, present and future is equally real. The "Block Universe" theory, covered above, is a form of externalism in which space-time is an unchanging four-dimensional block consisting of all space and all time at once. This means if we live in a block universe that our lives, including the evolution of all planets and stars in all galaxies, are predetermined. Thus we have no control of the future as our lives are fully mapped out for us down to the smallest detail. To me this seems preposterous as I believe all thinking creatures have free will making exact and complete predictions of the future an impossibility.

Skuld organisms and free will

How does RV relate to the "passage of time"? It is a well-known fact that living organisms have an innate ability to sense the passage of time. I think that all living organisms have ways of mapping and preserving relevant parts of their present or "now" such that their preserved maps dictate their actions into the future. Furthermore, I suggest that "skuld" organisms can also project their own actions, as well as those of others, into the future, beyond mere mathematical prediction. I define skuld behaviour as having free will, self-awareness, metacognition (awareness of ones' own thought processes) and problem solving.

In the computer science field of artificial intelligence, an intelligent agent is any device that perceives its environment and takes actions that maximise its chance of successfully achieving its goals. In order to do this an intelligent agent needs some form of map of the past. So therefore we need to include intelligent agents along with living organisms in the ability to sense the passage of time. It may well be that a class of skuld robot (a mechanical agent/entity spawned of artificial intelligence, and endowed with free will, self-awareness, metacognition, and problem solving [luckily for all us organics not yet invented, and hopefully never to be!]) will also have an innate ability to sense the passage of time and thus project their problem solving into the future. So we can see that living organisms and

intelligent agents have the mechanisms to store selected maps of the "now" so that appropriate future actions can be taken, all occurring in the "now". Thus the passage of time, as we perceive it, does not exist as anything else other than an illusion that is necessary for living organisms to exist.

A previously mentioned recursive enumeration is a computational process in which new things emerge from previous things by fixed laws and/or computational rules. As shown by Wolfram suitably complicated recursive systems might be seemingly capable of breaking out of predetermined patterns, something we consider a property of chaotic or non-linear systems, thus entering the realm of unpredictable behaviour.

But now, instead of considering procedures that can recursively call themselves, what if the procedure/program/brain can modify itself, thus changing and improving, and so on? Surely this type of recursion lies at the heart of the origins of consciousness? Many millions of years of evolution have honed consciousness to fully skuld awareness of an endless variety of things, both tangible like stroking the fur of a cat, to intangible like undergoing a 3-D virtual reality experience. And with this awareness comes the unpredictability of self-determination, also known as free will.

And so, in summing up, we can have logical and mathematical propositions that are undecidable; we can have structures in physics and mathematics that are uncomputable and we can have complex nonlinear systems whose output is seemingly unpredictable from the point of view of computability and we can have complex skuld organisms whose output is completely unpredictable due to free will.

ENDNOTES

1. Goldbach's Conjecture.

An interesting aside from Wikipedia: As a publicity stunt, the publishers (Bloomsbury USA in the U.S. and Faber and Faber in Britain) of *Uncle Petros and Goldbach's Conjecture* , a 1992 novel by Greek author Apostolos Doxiadis, announced a $1 million prize for anybody who proved Goldbach's Conjecture within two years of the book's publication in 2000. Not surprisingly, given the difficulty of the problem, the prize went unclaimed.

2. Universal Turing Machine (UTM).

Known as a universal computing machine in Alan Turing's writings, a UTM is an ideal computer that can compute anything that can be computed. Ideal means hypothetical in that the computer requires no power and has infinite memory (tape). In a nutshell, a Turing machine is a finite state machine (FSM) with the ability to read and write data to a tape. A finite state machine consists of a fixed number of states, such that when a symbol (rule) is input to the machine it changes state so that the next state depends only on the current state and the input symbol. For example, the cells in John Horton Conway's 'Game of Life' cellular automata[4] are FSM's with two states: 'alive' or 'dead'. A Turing machine is a finite state machine that has an unlimited supply of paper tape that it can write on and read back. Essentially the UTM reads a symbol from the tape, which is used as an input to the finite state machine and according to the symbol and the current state does three things:

a) it prints something on the tape
b) moves the tape right or left by one cell
c) changes to a new state

A UTM is the simplest implementation of "computing" and informally we say that if something can be computed then it can be done using a UTM. Thus a UTM is a model of of what is physically computable.

3. Halting problem

The 'halting problem' is the problem of determining, from a description of an arbitrary computer program and an input, whether the program will finish running or continue to run forever. In principle it looks reasonably easy. You examine the structure of the finite state machine and the symbols on the tape and work out if the result is halting or infinitely looping. Alan Turing proved in 1936 that a general algorithm to solve the halting problem for all possible program-input pairs cannot exist. Turing's proof was first published in January 1937 with the title "**On Computable Numbers, with an Application to the Entscheidungsproblem.**" It was the second proof of the assertion that some decision problems are "undecidable" (Alonzo Church's proof was first);ie. there is no single algorithm that infallibly gives a correct "yes" or "no" answer to each instance of the problem.

4. Game of Life (from Wikipedia)

The Game of Life is a cellular automaton devised by the British mathematician John Horton Conway in 1970.

The game's evolution is determined by its initial state, requiring no further input. One interacts with the Game of Life by creating an initial configuration and observing how it evolves. It is Turing complete and can simulate a Turing machine. The universe of the *Game of Life* is an infinite, two-dimensional orthogonal grid of square *cells*, each of which is in one of two possible states, *alive* or *dead*, (or *populated* and *unpopulated*, respectively). Every cell interacts with its eight neighbours, which are the cells that are horizontally, vertically, or diagonally adjacent. At each step in time, the following transitions occur:

1. Any live cell with fewer than two live neighbours dies, as if by underpopulation.
2. Any live cell with two or three live neighbours lives on to the next generation.
3. Any live cell with more than three live neighbours dies, as if by overpopulation.
4. Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

The initial pattern constitutes the *seed* of the system. The first generation is created by applying the above rules simultaneously to every cell in the seed; births and deaths occur simultaneously, and the discrete moment at which this happens is sometimes called a *tick*. Each generation is a *pure function* of the preceding one. The rules continue to be applied repeatedly to create further generations.

5. Ginnungagap

In Norse mythology, **Ginnungagap** is the primordial void, mentioned in the Gylfaginning, the Eddaic text recording Norse cosmogony.

> In the beginning ---
> There was neither sand nor sea
> Nor cooling billows,
> There was no earth nor heaven above
> --Ginnungagap was there –
> And nowhere was there grass.

I have called my aether theory '**Ginnungagap theory**' after the mystical space filled void of Norse mythology. I also have named my preon particle theory '**gimli theory**' after gimli, described as the most beautiful place in Asgard, the golden hall where the righteous go after Ragnarok. Gimli theory was originally based on matter/antimatter symmetry and can successfully reduce all matter to a single charged particle.

6. Skuld

I originally used the term sentient, which according to the Oxford dictionary means "able to see or feel things through the senses". To my thinking that means bacteria, amoeba and other similar lifeforms are sentient, and although this word is commonly used as I intended in science fiction, I felt that this word does not provide the meaning I needed.

So, I have coined the term "skuld entity" to mean an entity that has self-awareness, metacognition, awareness of others and awareness of the future. Skuld originates from the Old Norse literature name for the Norn of fate that represents the future.

In Old Norse literature the three Norns (demi-goddesses) of fate are female Jotuns (giants), named Urd for past, Verdandi for the present and Skuld for the future. Norns are always present when a child is born, and they decide its fate. Look up Norns and Jotuns on the internet for some fascinating insight to another culture's myths and legends.

7. Relative Verdandism

Using Verdandi as the name of the Norn of the present, mentioned above, I have coined the term "Relative Verdandism". This refers to my claim that one set of defined energy exists relative to another set of defined energy with dynamical force laws that describe the relative motion of both the energy forms in the Now (present). Ultimately Verdandism is able to do away with the concepts of space, time and spacetime, which are merely creations of skuld organisms, leaving only the object reality of Ginnungagap Theory, which describes the Universe solely in terms of its constituent matter and force particles, and their respective properties.

Note that in my context Verdandism is not Georg Brande's cultural radicalism, as some may know it to be.

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