

## The Meaning of Life, the Universe and Everything

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In the popular *Hitch Hiker's Guide to the Galaxy* series Douglas Adams plays with the Ultimate Answer to the great mystery of Life, the Universe and Everything. To everyone's surprise, the answer, which was determined after seven and a half million years of computation by the computer 'Deep Thought', is simply "42". But what was the answer (The Ultimate Question) to this riddle? In the *Hitch Hiker* series the Earth itself is a giant computer designed by 'Deep Thought' to undertake the equally long task of finding the Ultimate Question.

Unfortunately the Earth is destroyed by Vogons making way for a new hyperspace bypass on the eve of revealing all. The only answer that remains for the Ultimate Question is tattooed on the brain wave patterns of Arthur Dent, the sole Earth survivor:

*"What do you get if you multiply six by nine?"*

Of course, we know the answer to this question is not 42. But why did Douglas Adams choose 42 of all numbers? In this article we raise the curtain on the great mystery of Life, The Universe and Everything and argue that both the question and the answer really do make sense.

In many ways the *Hitch Hiker* series is a modern day equivalent of *Alice's Adventures in Wonderland* by Lewis Carroll, who was really Charles Lutwidge Dodgson, an Oxford don with a great love for mathematics and logic. The adventures of Arthur Dent are on a grander cosmic scale than the dream-like world of Alice.

First of all we recognize that 42 is a common link between the founding fathers of the scientific approach towards understanding the great mystery: Galileo Galilei and Isaac Newton. The former died in 1642 and the latter was born in 1642. Remarkably, in this year of English Civil War, the founder of Japanese mathematics, Seki Kowa, was born and the French scientist Blaise Pascal began inventing the first computing machine.

Rene Descartes' major philosophical work 'Principia Philosophiae', which was intended as a definitive university textbook to replace the traditional Aristotelian texts, was also essentially completed in 1642. In a letter to Constantijn Huygens in 1642 Descartes wrote that his work (an extension of 'The World')

*"... would be out already were it not that first of all I want to teach it to speak Latin. I shall call it the 'Summa Philosophiae', to help it gain a better reputation among the Schoolmen ..."*

The following extracts from the section on 'The Principles of Human Knowledge' summarize some of the main points:

Principle 6 *"We have free will ..."*

Principle 7 *"- I am thinking, therefore I exist -"*

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Principle 42 *“Although we do not want to go wrong, nevertheless we go wrong by our own will.”*

The freedom expressed by Descartes’ philosophy is at sixes and sevens with the determinism that emerged from the new scientific inquiry. In the deterministic view science is an omniscient prophet and the great mystery of Life, the Universe, and Everything was a tractable problem – at least in principle. In the same year of the Declaration of American Independence the French mathematician Laplace declared a state of universal dependence:

*“The present state of the system of nature is evidently a consequence of what it was in the preceding moment, and if we conceive of an intelligence which at a given instant comprehends all the relations of the entities of this universe, it could state the respective positions, motions and general affects of all the entities at any time in the past or future.”*

Paradoxically Laplace’s greatest legacy was the development of probability theory for disordered systems in which the future only depended on the past in a random fashion.

One of the most spectacular successes of the deterministic scientific approach to revealing mysteries of the universe was the accurate prediction by Edmund Halley of the return of a comet that both he and Newton had observed passing overhead. Both Halley and Newton died before the comet returned in the year predicted. Halley died in 1742.

There have been numerous successes of the deterministic approach since then and these have helped spur science on to even greater quests. Albert Einstein, who was awarded the Nobel Prize at age 42, was motivated by the ultimate quest:

*“I want to know how God created the world. I am not interested in this or that phenomenon, in the spectrum of this or that element; I want to know his thoughts; the rest are details.”*

In the realms of theoretical physics this burning problem became manifest in the search for a unified theory of everything and according to the theoretical physicist Stephen Hawking science may be close to solving this great mystery:

*“... the goal of theoretical physics might be achieved in the not too distant future, say by the end of the century. By this I mean that we might have a complete and unified theory of the physical interactions that would describe all possible observations.”*

Hawking was born in 1942. In this year of the Second World War, no Nobel Prize for physics was awarded but the Nobel Prize winning physicist, Enrico Fermi, set off the first self-sustaining atomic chain reaction.

The Ultimate Answer is important to science in other ways too. For example, the Nobel Prize winning theoretical physicist Richard Feynman (who incidentally received his PhD in 1942) has used the art of numerology to come up with some very convincing Ultimate Questions to the Ultimate Answer:

*“The ratio of the gravitational attraction to the electrical repulsion is given by a number with 42 digits tailing off. Now therein lies a very deep mystery. Where could such a tremendous number come from?... People have looked for such a large ratio in other places. They hope for example, that there is another large number, and if you want a large number why not take the diameter of the Universe to the diameter of a proton – amazingly enough it is also a number with 42 digits.”*

The number 42 also occurs in the origin of Darwin's 'Origin of the Species':

*"In 1842 I first allowed myself the satisfaction of writing myself a very brief abstract of my theory ..."*

The Ultimate Answer also appears in the history of rock music. Paul McCartney, Brian Wilson and Jimmy Hendrix were born in 1942. Elvis died at 42.

Sport is not immune either. Consider the rules of baseball. "The bat shall be a smooth round stick not more than 42 inches in length". The Daytona 500 race is usually restricted to 42 cars.

However, to find some of the most revelatory insights into the Ultimate Question and Answer we have to look deep inside the Earth where we find Alice's Adventures in Wonderland. To begin with we consider Alice's fall (perhaps the first ever bungee jump):

*"I wonder if I shall fall right through the earth! How funny it'll seem to come out among the people that walk with their heads downwards! The Antipathies, I think ... but I shall have to ask them what the name of the country is, you know. Please, Ma'am, is this New Zealand or Australia?"*

Assuming both Alice and the Earth to be uniformly dense and neglecting the effects of friction the time taken for Alice to fall right through the Earth can be readily calculated by undergraduate physics students. The answer is 42 minutes.

Later in Alice's adventures the number 42 appears out of nowhere as the number of the oldest rule in the book:

*" 'Rule Forty-two. All persons more than a mile high to leave the court.'"*

*Everybody looked at Alice.*

*'I'm not a mile high,' said Alice.*

*'You are,' said the King.*

*'Nearly two miles high,' added the Queen.*

*'Well, I shan't go, at any rate,' said Alice: 'besides, that's not a regular rule; you invented it just now.'*

*'It's the oldest rule in the book,' said the King.*

*'Then it ought to be Number One,' said Alice."*

But perhaps the most significant incidence of the Ultimate Answer in Alice's adventures is that it is the key to the solution of the Ultimate Riddle as to who Alice is. Just after Alice's fall she muses:

*"Who in the world am I? Ah, that's the great puzzle!... I'll try if I know all the things I used to know. Let me see: four times five are twelve, and four times six is thirteen, and four times seven is – oh dear! I shall never get to twenty at that rate!"*

In *The White Knight* A.L. Taylor suggests that the way to make sense of Alice's multiplications is to start the table in base eighteen and then to add three to the base each

time we add one to the multiplier, viz:

$$\begin{aligned}4 \times 5 &= 12_{18} \\4 \times 6 &= 13_{21} \\4 \times 7 &= 14_{24} \\&\vdots \\4 \times 12 &= 19_{39}\end{aligned}$$

In this table each time the multiplier is increased by one so is the product but then it all breaks down if Alice tries to multiply four times thirteen (in base 42). The answer is not 20 and as Francis Huxley points out in *The Raven and the Writing Desk* this leaves Alice at sixes and sevens (whether added to give 13 or multiplied to give 42).

We note that the original edition of *Alice's Adventures in Wonderland* contained 42 black-and-white line drawings by Sir John Tenniel.

Finally we turn to the new theory of 'Chaos' to provide an alternate solution to the whole puzzle. Chaos, which is about order within disorder within order was re-discovered in 1942 by the American poet Wallace Stevens. The fundamentals are described in his poem 'Connoisseur of Chaos':

- A. *A violent order is disorder; and*
  - B. *A great disorder is an order. These*
- Two things are one.*

This harmony of order and disorder in Chaos was also known to the philosopher Immanuel Kant who cited it as clear evidence for the existence of God;

*"... there is a God precisely because Nature itself, even in chaos, cannot proceed except in an orderly and regular manner."*

The mathematical key to the order within disorder in Chaos is the generation of randomness from a deterministic algorithm. This can occur in the game of cricket provided the umpire's behaviour is always deterministic since according to Law 42 in the rules of cricket, the umpire must inspect the ball "*frequently but irregularly*".

A fashionable new game that has emerged from Chaos is that of trying to deduce whether a series of irregular behaviours has been generated by a deterministic algorithm or a random algorithm. If sufficient numbers of data points,  $N$ , are available then a deterministic algorithm, if it exists, may be reconstructed from the data as a *strange attractor* in an abstract mathematical space called *phase space*. One signature of the strange attractor is its dimension,  $D$ , which can be readily calculated using what is called the Grassberger-Procaccia algorithm. According to recent work by theoretical physicists Jean Pierre Eckmann and David Ruelle the values obtained for  $D$  are meaningless unless  $D < 2 \log N$ .

This leads us to the Ultimate Question to the Ultimate Answer which was suggested by Ruelle at a scientific meeting in which, according to the organizers, "... it was a declared objective of the conference to be the last, as well as the first, of its kind on Chaos in Australia." Ruelle's 42 was presented at this conference as the Ultimate Dimension of the Strange Attractor for Life, The Universe and Everything. In his article 'Chaos: The science and the fiction' Ruelle writes:

*"I think that what happened is this. The supercomputer took a very long time series describing all it knew about 'life, the universe, and everything' and proceeded to compute the correlation dimension of the corresponding dynamics, using the Grassberger-Procaccia algorithm. This time series had a length  $N$  somewhat larger than  $10^{21}$ . And you can imagine what happened: after many years of computation the answer came: dimension  $\simeq 2 \log N \simeq 42$ ."*

In fact work on 'Eniac', the first electronic digital computer, was begun in 1942. A computer the size of the Earth is not too far removed in spirit from the size of the original Eniac. It took up a whole room and weighed more than thirty tonnes.

There are no doubt many more important instances of the Ultimate Answer that have already occurred or are yet to appear. For example, Bill Clinton was the 42nd president of the United States of America? The 42nd Prime Minister of Australia was dismissed by the Governor General!

However, after carefully sifting through the available evidence we suggest the following solution to the Ultimate Answer to the Ultimate Question embedded in the brain waves of Arthur Dent:

*"What do you get if you multiply six by nine?"*

Clearly, like Alice, the sole Earth survivor is also at sixes and sevens and we now see that  $54 = 4 \times 13 + 2 \times 1$ . So the answer really *is* 42, but in base 13. Whether intentional or not, Douglas Adams has left us with a legacy in the whimsical mathematical tradition of Alice in Wonderland.