UNLOCKING
CONSCIOUSNESS

# BRIAN MIND FORUM

## Appendix 027

### Physics of Information
### (Infodynamics?)

Science of Information.

> *Quantum physicists argue that when the wave form of a photon collapses a* ***'bit' of information is created****. This is the basis of the famous Schrödinger 'cat' hypothesis. We note that the structure of information bears a remarkable resemblance to the structure of energy. It offers a challenge to explore if information obeys a set of laws of Infodynamics (?), much as the nineteenth century scientists constructed the laws of thermodynamics to account, inter alia, for how steam engines worked. We quote John Wheeler's axiom that 'matter tells space how to curve: space tells matter how to move' (not a bad definition of information). It makes the theory of general relativity easier to understand and apply. Do we need to add the term 'I' to the world's most famous equation? A hundred years ago the identification of a 'quanta' of energy- the smallest measurable unit of light (the photon) caused a revolution in our perception of 'quantum' physics. Could a definition of a 'quanta' of information stimulate a similar advance in neuro-physics?*

The object of this work is to analyse and define information as a necessary precursor to studying and understanding intelligence

Over the last century and a half a great deal of observation, research and work has gone into understanding energy. The laws of thermodynamics have been formulated and very thoroughly tested and the relationship of energy to mass explored in, perhaps, the most famous formula in science $e = mc^2$.

The last term introducing the most famous effect that energy always flows. It is a key consideration in our understanding of the operation of the brain. Simple brains monitor the sensory organs sending a stream of electrochemical signals to the brain, where, we know they are processed and sets of neural instructions immediately stream out to the muscles to act. It is a very basic activity of all animals and the driver of the survival of the fittest aspect of evolution. There is no facility to interrupt that stream of signals, pause, evaluate alternatives, and then chose to execute the most favourable. Indeed, the ability to find a way round this

fact of nature, is the basis of thinking, the ability to imagine, and the foundation of the sentience of homo sapiens.

However, Einstein's famous formula and much thinking since has not satisfactorily addressed a conundrum. We know a lot about energy, but we know very little about how energy knows what to do.

In the last few years more and more examples of the duality of living systems have been coming to light. DNA is a long stream of information, nucleotides. Of the four base pairs Cytosine, Thymine and Guanine are the building blocks that convert DNA to RNA, then Amino acids all the way to the proteins that make up our bodies, while Adenine has the ability to generate the energy to carry out these functions. The neurons in the brain are unable to carry out any function, but they provide the framework for the patterns of electrochemical signals of the mind to create our sentient selves. The integrated circuits in a computer are useless without a program.

Maxwell put forward a compelling argument that in certain circumstances molecules (information?) could get hotter without any work which breaks the laws of thermodynamics (hence are 'demons'). However, in 1929 it was shown that information has/is a form of energy. Recently researchers at Luxembourg have successfully used this effect to create micro-refrigerators to cool integrated circuits.

This suggests that the 'mass' in $e = mc^2$ might be information in two states: (1) facts and building blocks: or (2) sets of instructions. If this turned out to be true it would fundamentally effect many long held views. It could impact on the apparent discrepancy between quantum and conventional physics. Should $e = mc^2$ be upgraded to $e = (mi1)c^2$ and $e = (mi2)c^2$.

That would incorporate information into the laws of thermodynamics and much else.

A more radical suggestion is that information is a parallel force to energy. That would enable us to go further still and argue that Energy is the Hardware of the systems of the Universe and Information is the Software?

[ If you read the last longer paper (or the figure sidebar D) I sent you ( i.e. The Semantic Turing Machine ....) on page 3, item 5 you will see that quantum phase fundamentally modifies the 2nd Law of Thermodynamics so as to include the ideal Carnot heat engine action in a single heat bath that results totally new states matter (i.e. fermions) whereas the classical ideal Carnot engine requires two heat baths at different temperatures! This has been verified experimentally.
Thus, in this physical world/cosmology entropy essentially also acts as a measure of information (and this is happens only possible because of the Einstein Conservation of energy, momentum and mass describes the fermions) Hence while the cosmos as a whole is running down i.e. entropy is increasing, order and indeed increasing order will also takes place under the right conditions/circumstances. ie those appertaining to semantic information (i.e. for example living DNA/RNA genetic systems) ]

Further reading: Maxwell's demon, Entropy, information, computing. ISBN 0-691-08727-x. 1990 Princeton university press.

## Contribution of Claud Shannon.

No paper on information would be complete without a reference to the massive contribution of Claud Shannon. Without his seminal work on the transmission of information none of the whole internet, world wide web infrastructure would exist.

Reprinted from Wikipedia:-
Information Theory, and its widespread availability is behind its current overwhelming success.

SHANNON'S "MATHEMATICAL THEORY OF COMMUNICATION"

"Before 1948, there was only the fuzziest idea of what a message was. There was some rudimentary understanding of how to transmit a waveform and process a received waveform, but there was essentially no understanding of how to turn a message into a transmitted waveform."
[Gallager, Claude Shannon: A Retrospective, 2001 pg. 2683]

In 1948, Shannon published his paper "A Mathematical Theory of Communication" in the Bell Systems Technical Journal. He showed how information could be quantified with absolute precision, and demonstrated the essential unity of all information media. Telephone signals, text, radio waves, and pictures, essentially every mode of communication, could be encoded in bits.
The paper provided a "blueprint for the digital age".

## History

Information Theory is one of the few scientific fields fortunate enough to have an identifiable beginning
- Claude Shannon's 1948 paper. The story of the evolution of how it progressed from a single theoretical paper to a broad field that has redefined our world is a fascinating one. It provides the opportunity to study the social, political, and technological interactions that have helped guide its development and define its trajectory, and gives us insight into how a new field evolves.

We often hear Claude Shannon called the father of the Digital Age. In the beginning of his paper
Shannon acknowledges the work done before him, by such pioneers as Harry Nyquist and RVL.
Hartley at Bell Labs in the 1920s. Though their influence was profound, the work of those early pioneers was limited and focussed on their own particular applications. It was Shannon's unifying vision that revolutionized communication, and spawned a multitude of communication research that we now define as the field of Information Theory.

One of those key concepts was his definition of the limit for channel capacity. Similar to Moore's Law, the Shannon limit can be considered a self-fulfilling prophecy.
It is a benchmark that tells people what can be done, and what remains to be done – compelling them to achieve it. What made possible, what induced the development of coding as a theory, and the development of very complicated codes, was Shannon's Theorem: he told you that it could be done, so people tried to do it.

In the course of our story, we explore how the area of coding, in particular, evolves to reach this limit. It was the realization that we were not even close to it that renewed the interest in communications research.
Information Theory was not just a product of the work of Claude Shannon. It was the result of crucial contributions made by many distinct individuals, from a variety of backgrounds, who

took his ideas and expanded upon them. Indeed, the diversity and directions of their perspectives and interests shaped the direction of Information Theory.

In the beginning, research was primarily theoretical, with little perceived practical applications.
Christensen says that the innovator's dilemma is that he cannot garner support for his new ideas because he cannot always guarantee an end profit. Fortunately, Information Theory was sponsored in anticipation of what it could provide. This perseverance and continued interest eventually resulted in the multitude of technologies we have today.

In this paper, we explore how these themes and concepts manifest in the trajectory of Information Theory. It begins as a broad spectrum of fields, from management to biology, all believing Information Theory to be a 'magic key' to multidisciplinary understanding. As the field moved from this initial chaos, various influences narrowed its focus. Within these established boundaries, external influences such as the space race steered the progress of the field. Through it all, the expansion of Information Theory was constantly controlled by hardware.

Aftab, Cheung, Kim, Thakkar, Yeddanapudi

INFORMATION THEORY & THE DIGITAL REVOLUTION. 36.933 Project History, Massachusetts Institute of Technology

## How do we benchmark 'Artificial Intelligence' and 'Thinking Robots'?

The first question must be 'How do we describe and define Human Intelligence? The great minds of the past and present do not agree: There are a plethora of definitions.

However, all the proposed definitions have two things in common:

1. All forms of intelligence are about processing information.
2. All descriptions and definitions of intelligence are about speed, efficiency and competition to be best, then better.

In the beginning evolution favoured the efficient – they survived. Could the foundation benchmark of all intelligence, therefore, be the ability to "respond to incomplete information fast", from which all other intelligence derives?

Nowadays we can identify many types of Intelligence including traditional 'Acquisitional intelligence' – learning, memory, current academic education: 'Physical intelligence'- dexterity, mind muscle co-ordination, musicality, arts and crafts, sport: 'Emotional intelligence'- leadership, empathy, co-operation, behaviour, tolerance: 'Creative intelligence' - research, invention, problem solving, imagination, prediction, design. programming: 'Medical intelligence' – health behaviours, whole body responses, psychosomatic and reciprocal immune system relationships.

We only have one benchmark of human intelligence against which to measure artificial intelligence in computer systems and robots, let alone gene editing and synthetic biology: namely the controversial 'Intelligence Quotient' or IQ and similar

tests, which together with ‘GCSE’, ‘A’ ‘9’ level’, ‘IB’, and ‘EBAC’ only attempt to measure and develop one relatively narrow band of human intelligence and skills.

How do we design benchmarks for the whole rainbow of human ability?

## The new science of INFODYNAMICS.

The invention of steam engines enabled us to process fuel into energy and led to the science of Thermodynamics. Computers are the first machines to enable us to process information into intelligence. Is this the dawning of the age of Infodynamics?

1. A possible first law of Infodynamics is that Intelligence cannot operate in a vacuum. It requires Information.

2. A possible second law of Infodynamics is that Information is consistent, reproducible patterns of behaviours and activities.

3. A possible third law of Infodynamics is that Information is a catalyst and does not change, however many times it is used.

4. To establish a fourth law of Infodynamics we need to identify the smallest measurable unit of Information. Candidates are [1] a reciprocal of a photon (the smallest measurable unit of energy), [2] a Q-Bit, [3] a unit of difference (if nothing changes there is no information).

One school of thought suggests information needs agency. Someone to hear, see or otherwise register it.

BMF Sep 2017.