Quantum state of the system is a SQ mixture of superposed informational fluxes of different propagation velocities acting both as individual and collective determinants of the outcome's specific complexity index.

At a most fundamental level of Reality, we emphatically replace the notion of "causal chain" by the one of "causal loop", the only accurate description of the background of a never-starting and never-ending Universe.

Just "consciousness" IS the Existence itself with or without Space/Time manifestations. BEING comes first, and this Being IS conscious escaping any Time constraints (trans-temporal domain). The extended "Soul" conjecture becomes in our model, for the first time in the History of Science and Philosophy, not only a perfectly argued and acceptable ontologically “prime” component of Reality, but its origination and overall control domain of manifestation, too. We hope to contribute to a major paradigmatic shift centered on these new and advanced understandings.

Our conceptual framework is highly consistent with Vedic traditions (also with similar Kabalistic ones) in designing Informational structures and processes as pro-active essence of Reality at all its scales of manifestation. Transcending these ancient models and the Cartesian dualism, we defend an asymmetrical monistic view where Information is extended into Space-Time as Energy/mass, without affecting its ontological primacy (hence its ability to form pre-energetic configurations in its own regime). The Conscious Structure (entity) is defined by its specific gradient of Informational complexity which allows for its active interaction with Informational combinatorials of different gradients from its own. Individual and Universal Consciousness are described as super-implicated orders of the same SQ-configured processes. Seen the infinite SQ partition of the Quantum (down to the Bhutatmas as infinitesimal units both of energy and Information where the hyper dimensional link is performed), a self-conscious structure is no way dependent upon Quantum-level events, but can modulate such. Hence its natural feature of preserving cognitive components in their integral range after its disconnection from Brain's Quantum activity. The "show" is not affected by a technical dysfunction in the Radio receiver. The background process may be linked to the Quantum processes in Brain but it may be also disconnected.

---

Session: Scientific Critique of Life Science

Talk 1: Information Theory and Living Organism

Sisir Kumar Roy, Ph.D. and Nepal Banerjee

National Institute of Advanced Studies, IISc Campus, Bengaluru, India

Abstract:

Norbert Wiener and Claude Shannon introduced information theory independently in 1948. Shannon introduced it to quantify the amount of data that can be transmitted by communication devices. It causes considerable confusion when it was applied to biological system. This theory deals with the capacity of the system to transmit information, not with the meaning or content of the transmitted information. Here, in this paper, we make a critical analysis regarding the applicability of this information theory in molecular biology, gene and specificity and the origin of life. It raises the controversy between the reductionist and non-reductionist in the context of use of information theory in living organism.

Keywords: Shannon Information, Gene specificity, Lock and Key concept, Origin of Life, Reductionist, Anti-reductionist, Semantics and syntactic aspects of information.

The real solution to the mind-brain-body problem rests in how information is to be conceived in living things, in general, and the brain in particular. -J.A.S Kelso, 1995.

1. Introduction

In English dictionary the word information refers to knowledge communicated or received concerning a particular fact or circumstance. The word in-formation is derived from Latin “informare” which means "give form
to”. The etymology thus connotes an imposition of structure upon some indeterminate mass. The current confusion started around mid of twentieth century when the term was used in the field of cybernetics, computer and data transmission. Norbert Wiener and Claude Shannon made pioneering contributions in the field of information. Wiener1 in 1948 introduced the concept of information as a measure of the degree of organization of the system where as Shannon2 in the same year independently used it as something that reduces uncertainty in a message. According to Wiener1, founding father of cybernetics, information is considered as an intrinsic property of all organized forms of matter and energy reflecting the degree to which the components of the system are organized in contrast to randomness. In this framework the information is considered to be the negative of entropy where the en-tropy is a measure of disorganization or disorderliness. Shannon introduced a mathematical theory of information where he deals with the capacity of the system to transmit information and not with content or meaning. It means a message as completely nonsense and the other loaded with meaning may contain the same amount of information in Shannon framework. Edelman and Tononi3 raise interesting question:

First we must ask whether the term information can be used to describe a state of nature in the total absence of a human observer. Can information be solely an objective term? If it is defined by physicists as a measure of order in a far from equilibrium state, then by the terms of that definition, in a “God”’s eye view. If however, information is defined in a way that requires a historical process involving either memory or a heritable state, then information can only have arisen with the origin of life.

The recent advancements on information processing, storage and transmitting data are not able to throw light how one can add meaning to information within Shannon’s framework. The central issue is whether meaning is an integral property of the objects or events or something the observer attributes to them.

The entire range of living entities starting from unicellular objects to plants and animals are able to detect and respond to those information which are meaningful to them. For conveying meaning to information to the entity it has not only to be detected but also have an effect on the entity that detects it. The cells, molecules and even every species are designed in specific manner so as to detect and respond to the type of information needed to function and adapt it in particular environment. Many attempts have been made to understand the way certain aspects of information have an effect on the recipients that detect them but not widely accepted by the community. In a recent book Anthony Reading4 introduced the term meaningful information which refers specifically to a detected pattern of matter or energy that generates response in a recipient. "The response may be either behavioral one, like flight or flight, a physiological one, like salivating or sweating or a structural one, like reconfiguring the neural connection. If the detected pattern of matter or energy has no effect on a recipient, it is considered to be meaningless". This way of thinking is a pragmatic approach of Charles Saunders Peirce5 and William James6. In the present paper we are not going to discuss about this pragmatic approach, rather we will discuss about the foundational issues related to the applicability of Shannon informative theory to living entities. This will help us to understand the challenges of using information theory in biological domain.

In section II we discuss about information theory especially Shannon’s work for convenience. Then the applicability of this theory to Molecular Biology domain will be critically analyzed in section III. The gene specificity and Lock and Key concept will be discussed in section IV. Finally possible implications are elaborated in section V.

2. Concept of Information In Science:

The qualitative definition of information is that how much knowledge we have for a particular system so that we can predict the system state in a particular instant. So when the number of micro-state of the system is less then it is easy task for us to tell about present state of a particular system and we can say that system is more predictable. Similarly when system posses large number of states then system become less predictable and the uncertainty become large to point out the present state of the system. Again when our system is more random then the uncertainty about the state of the system increases and simultaneously information decreases. So clearly we can say that the information is opposite to the randomness of the system and randomness of a system is measure by the entropy. That is why we usually the information is defined as a negative of entropy and can be define as I=-S. The entropy in statistical mechanics is defined as $S=k\ln W$. Here the k is Boltzmann constant and W is the number of micro-states of a particular system. We know that when the W, number of micro-state is large,
system can stay as a many deferent way and the predictability of a system is less. At this point, its look more intuitive why the information is negative of entropy of the system. We can pose the problem that when the possible micro-state increases then entropy also becomes large having randomness becomes high consequently. Subsequently the system become more uncertain making the predictability decrease which ultimately reduces information.

Let us take a simple example to understand this basic idea of information and how it gets related with entropy. Suppose we have tossed a coin and the possible outcome is either head(H) or tail(T) with sample space as \([H,T]\) and the probability is of both the sample is equal and it is \(1/2\). Then the possible micro-state for one coin toss is two. So here \(W=2\) and the entropy is \(S=k\ln2\).

Now if we toss two coins consecutively then our sample space for this event increases and number of configuration also increases. In this case the sample space is \([HH,HT,TH,TT]\) and number of possible configuration is \(W=4\). For this case the micro-state is equally probable and the joint event can occur with four possible way. But the system state after a two consecutive toss, become less predictable than the previous event when we have toss one time only. The entropy here can be written as

\[
S = k\ln4 \\
S = k\ln2^2 \\
S = 2k\ln2
\]

In a similar way if we toss coin \(n\) times the possible number of configuration is \(W=2^n\) and the entropy is

\[
S = k\ln2^n \\
S = k\ n\ln2
\]

It has been clearly shown that entropy increases linearly with number of trials of this event. So here by this simple example what we can observe that when the system have large number of equally probable choices to settle itself after the experiment then the predictability of the system become less and less and same way the information becomes less.

We can look this idea of information in a different language which is defined by Shannon. Considering Boltzmann definition of entropy then there \(W\) is the number of microstates i.e. number of possible configuration of a system, all the configuration is equally probable then the probability of a particular state is

\[
p_i = 1/W \\
W = 1/p_i
\]

So the entropy definition looks like

\[
S = k\ln W \\
S = k\ln(1/p_i) \\
S = -k\ln(p_i)
\]

This is the definition of Shannon for the entropy and can be extended when the probability of micro-state is not equal in which case the definition of entropy is modified as

\[
S = -\sum_i p_i\ln p_i
\]
The last expression is valid for both equal and unequal probability of the possible micro-state. Hence, we define information as negative of entropy

\[ I = k \sum_i p_i \ln p_i \]  

Here we can check an interesting property that when all possible micro-state are equally probable the entropy becomes larger than the unequal or bias probability distribution. It is interesting to note that the relative information of the system increases for unequal probability distribution. So the deviation from equiprobable state decrease the entropy and this very reduction of entropy give rise the information of the system. Generally, we can say that a system will be more informative when the probability of possible micro-state of a system is unequal.

Sometimes we define information as the deviation of entropy from equal probable state

\[ D = k \ln a - k \sum_i p_i \ln p_i \]  

Here “a” is the probability of a particular state for equal probable case.

### 3. Information Theory and Molecular Biology

According to Shannon information is defined as a purely quantitative measure of communicative exchanges which can be analyzed at the level of physical data. But it is well known that data are abstract objects whose representations require physical support. It is to be noted that while one needs to understand the syntax at the level of crude data, semantics refers to the objects foreign to messages i.e. what we call meaning. So for semantic aspect of information one requires not only the acquisition of data i.e. syntactic information but also all the relations associated with these pieces of information what we call knowledge or stratification of knowledge (may be called experience). It may said that syntactic aspect of information which depends on the data is objective while the semantic aspect is (inter) subjective since it depends on experience shared by the systems.

It becomes evident if we analyze the assumptions behind the definition of information by Shannon. One of the assumptions behind the definition of information by Shannon is: information depends solely on the probability of the message not its semantic content. If a message is unlikely to happen, it contains more information in contrast to it contains less information for more likely happening of the message. Shannon whose emphasis was to have increasing performance of communication systems, was mainly interested in the syntactic aspect of information.

The success of mathematical theory of syntactic aspect of information in communication systems inspires many people to apply it to the field of Linguistic, Sociology, Psychology and Molecular biology. Here, we will restrain ourselves to discuss about Shannon’s approach to molecular biology since information plays a profound and debatable role in this fascinating scientific discipline. In fact, biologists frequently talk about the information content of the genes, genetic heritage, and information conservation among number of species. Moreover, the concept information is the subject of an important assumption in Central Dogma of Molecular Biology. Roughly speaking, according to this dogma information flows from DNA to the proteins similar to flow of information from sender to receiver in communication system introduced by Shannon. DNA may be considered as a sequence of 4 letters alphabet (A,T,C,G) while protein is considered to be a sequence of 20 letters (20 amino acids). It appears that Shannon information theory may be applicable for understanding the flow of information. However, Shannon information theory developed so far to understand the syntactic aspect of information. Often, biologists speak about the information content of DNA, introns, exons and the information theory is so far used to analyze the data sequence i.e. at the syntactic level. Several attempts have been made to extend Shannon information theory so as to include the semantic aspect but no comprehensive theory is available within Shannon’s framework.

It is important to be mentioned that the identification of information with negative entropy creates a tension even without considering the context of biology. Brillouin states

*Take an issue of New York times, the book on cybernetics and unequal weight of scrap paper. Do they have the same entropy? According to the usual physical phenomena, the answer is yes. But for an intelligent reader, the amount of information contained in these three bunches of paper is very different. If information means negative entropy as suggested by Wiener, how*
are we going to measure the new contribution of entropy?

Essentially, Brillouin’s claimed that the specificity of the value of information (encoded) can be very different in individual cases, however, they may have the same physical entropy. Let us now discuss the concept of specificity in Biology and Shannon information theory in the next section.

4. Gene Specificity and Lock and Key Concept:
Harold first gave the concept of gene specificity in plant diseases. He observed in his study that the inheritance of both resistance in the host and parasite ability to cause disease is controlled by pairs of matching genes. One is a plant gene called the resistance (R) gene. The other is a parasite gene called the avirulence (Avr) gene. Plants producing a specific R gene product are resistant towards a pathogen that produces the corresponding Avr gene product. According to Octavio Martínez and M. Humberto Reyes-Valdes:

"Gene specificity is defined as the mutual information between the tissues and the corresponding transcript, allowing detection of either house keeping or highly specific genes".

There is number of different example of this gene specificity in nature and this kind of gene specificity is similar to understanding of lock and key concept in biology. Lock and key concept is a simple concept to understand function of different enzyme and protein in our digestive to immune system. In this case we observe that a particular protein react with a specific protein and a particular anti-body fit to protect a particular antigen. So there must be a kind of connection between this protein and enzyme from their genetic level and their genetic code which synthesize this kind of lock and key protein. The details study of correlation between this two genetic sequence only give us a satisfactory answer about how this two specific genes are connected with each other following this lock and key relation. Similarly in virus and bacterial organism we observe same kind of mechanism which firmly establishes this lock and key concept. Different virus and bacterial organism changes their properties to become more resistive or harmful during evolution and the whole process underlying in the genetic material manipulation in this organism according to their host. Similarly our immune system finding different alternate way to defend this new antigen and that also is being regulated by this genetic code related to this immune system. So we can think this mechanism as a competition between two genetic code which are finding clever ways to organize them and defeat each other. It is a ever ending process and via this competition they are correlated to each other. It could be interesting to study if we can understand the gradual development and evolution of this virus in connection to human immune system from genetic level and trace how these genes are modifying themselves for competing with their lock or key gene within the framework of information theory.

Thomas G. Whitham have discussed about this genetic specificity from a different aspect and reported how different vector and plant depend on each other by this genetic specificity. He also mentioned the importance of this kind of genetic specificity which is responsible for genetic diversity and evolution. We know that a particular vector select some particular type of plant for their living activities. Sometime different virus and fungus make host some vectors to spread over rapidly in a particular types of plants. This kind of interrelation is only possible due to some kind of hidden correlation underlying the gene of this plant and vector. Now this plant being host of particular vector changes to different species when the climate and other factor changes and with this change in the vector also modify themselves to fit for this particular species. Thus when a plant modify itself to prevent infection from a particular virus as well as from the harm of a particular vector then virus and vector also change its character to survive in this particular species of the plant. So different species and diversity appears in both plants and vector due to this dependency with each other. This phenomena usually we call genetic diversity which is crucially important factor for genetic stability of a particular species. It is important to note that this genetic correlation being a responsible factor for this genetic specificity can be represented by information theory. Shannon information formula is most easy and helpful way to understand this correlation. Octavio Martínez at al discussed about this gene specificity and showed that how we can express this idea of specificity of a gene corresponding particular tissue using Shannon’s formula. They define the diversity of the transcriptome of each tissue which can be quantified by Shannon’s entropy formula:

\[
H = - \sum_{j=1}^{g} p_j \log_2 p_j
\]
The transcriptomes of each tissue can then be simply described as the set of relative frequencies, \( P_{ij} \), for the i-th gene and j-th tissue. However, various statistical issues in connection with estimation theory need to be resolved before applying any such framework.

5. Functional-Structural tension and Semantic Metaphor
Shannon information has been studied in the context of origin of life and modeling of the properties of living systems. In 1992 Manfred Eigen introduced a theory regarding the emergence of life on earth. Here, the concept of information plays an important role. He equalizes the origin of life with the origin of genetic information and characterizes the molecular evolution in term of information theory. This theory is known as Hyper cycle theory. According to Eigen

*All the varieties of life have a common origin. This origin is the information, in all living beings, is organized according to the same principle.*

However, the reductionist intentions of Eigen face severe limitations. It is simply due to the fact that it has not been possible to characterize the informational content of the genetic sequences in order to suggest the interaction of genetic sequences and functional molecules in a satisfactory manner without resorting some principle which is not contained in polynucleotides molecular structure. Eigen’s theory fails to resolve the tension between the structural and functional nature of genetic information. In fact, the current research of biologists who held the question of nature of genetic information as an epistemic object did not resolve the tension between structural and functional approach to their study of object. In the book “A Physicist Looks at the Life” (in Chinese, 1994) Luo states

*How did the biological order emerge from a physical world, or how was life information accumulated for a primitive life?” This question still remains a riddle at present time.*

6. Controversy over the concept of information
Before dealing with the concept of information as such, we discuss about the definitions of information and its dependency on observer.

6.1 Information and Observer Dependency
There are many potential definitions of information. At the one end, information may be defined as a thing where as on the other end information may be defined as a psychic construction. Within this continuum, logically speaking, following Lars Qvortrup it is possible to identify four concepts of information:

(a) Information can be defined as something existing in the external world like heat, electricity, etc. Thus, information is defined as something identifiable in the real world, i.e. as a difference in reality.

(b) Information is defined something in the external world which causes change in the psychic world. Here, information is defined as a difference in the real world which causes difference in mental world.

(c) Information may be defined as a change in the psychic system which has been stimulated by a change in the external world.

(d) Information may be defined as something only in the human mind, a concept or an idea. Here, information is defined as a difference, now however as a cognitive difference which brings forth (an idea about) an external world.

Let us analyze first when we speak about Information as difference in the external world. It means that something is different from something else makes this something information. If everything were equal, no difference could be observed. For example, we give the name a star as a bright spot in night sky which is taken as information. The implication is that information is something in the material world, independent of the observer. The metaphor that Information as an image of flowing substance which can be sent though a pipeline constitutes the basis of communication model of Claude Shannon.

This metaphorical image was emphasized in Encyclopedia Britannica:

*A basic idea in communication theory is that information can be treated very much like a physical quantity such as mass or...*
energy. Now if information is considered to be something like physical quantity, then a measure has to be defined. To define measure one needs to know the nature of information. In Shannon theory information is thought of as a choice of one message from a set of possible messages.

(1) Two conflicting metaphors are being used in this framework: like water flowing in a pipe.
(2) A choice made by an information provider, and a forced choice made by a receiver.

As per the second metaphor concerned the information sent is not necessary equal to the information received because making any choice is nothing but a comparison with a list of possibilities i.e. a list of possible meanings. So much of the confusion related to concept of information is related to the confusion created by using the conflicting metaphors used in Shannon framework: is information an autonomous quantity, or is information always per se information to an observer?

6.2 The Reductionist - Antireductionist Controversy

Crick in his book\textsuperscript{15} states

so far everything we have found can be explained without effort in terms of the standard bonds of chemistry - the homopolar bond, the van der Waals attraction between non-bonded atoms, the all-important hydrogen bonds, and so on.

It essentially says since all chemistry is based on laws of quantum theory, quantum mechanics is the underlying theoretical basis of life. Two eminent scientists of twentieth century Elsasser\textsuperscript{16} and Wigner\textsuperscript{17} made serious attempts to find if the living systems obey the laws of physics and chemistry. Both faced serious difficulties and neither Elsasser nor Wigner believes that quantum mechanical laws are adequate to explain the living system. Here, the controversy is

(1) The theory is now complete and all of life can be reduced to the known laws of physics.
(2) For anti-reductionist they believe the discovery of new laws will be necessary to explain the living system.

Michel Polanyi\textsuperscript{18} is considered to be one of the spokesmen of the anti-reductionist school. Polanyi attempted to show why quantum theory is in-adequate in explaining the living system He based his arguments on information theory. He states

all objects conveying information are irreducible to the terms of physics and chemistry.

He believed that as living system is a machine, there exists a higher operational principle governing the designing and function of a machine which cannot be deduced from the description of hard ware. Polanyi talked about higher organization principle which includes the laws as well as fix the boundary conditions. The laws of physics considered separate than the boundary conditions. In this sense, this is the anti-reductionist view. The rapid developments of digital computer raise the issue once more by the end of twentieth century. The computers are machines that process symbolic forms of information in an extremely rapid fashion according to built in algorithms. Brains on the other hand process both sensory and symbolic information and interpret its meaning, under-standing relationship. But we experience as feeling is information about the meaning which computers cannot do it. Computers, thus have no awareness of what information they process means.

Information theory is a set of mathematical procedures discovered by Shannon. Young\textsuperscript{19} rightly pointed out

The Shannon formula is a measuring device; to equate it with information in its general sense is to confuse a measuring device with what it measures. A formula that measures the amount of apples in a barrel obviously is not the same as the apples.

References
1. Norbert Wiener (1948) Cybernetics: or control and communication in the animal and the machine, John Wiley and Sons, NY.
Talk 2: The Seventh Law of Morphogenetic Evolution
Mark A. S. McMenamin, Ph.D.
Professor, Department of Geology and Geography, Mount Holyoke College, South Hadley, Massachusetts, USA

Abstract

The seven laws of morphogenetic evolution allow us to better comprehend the constraints and possibilities of evolutionary change. The Seventh Law states that morphogenetic field vectors may be bundled/bunched or dilated/herniated in a geometrically regular fashion to generate compound eyes or other torological traits. The influence of the Seventh Law is very ancient, for example, it may be observed in the pre-Cambrian chiton Clementechiton sonorenus. The occurrence of the seven laws implies that we exist in a law-governed universe, where the operation of laws of morphogenetic evolution leads to repeated and predictable outcomes in the history of life.

It is possible to mistake the "ubiquity of consciousness" (Shanta 2015) with the operation of laws that deliver, through the course of evolutionary time, a series of approaches to the endpoints foreordained by the laws in question. Expressing an amusing yet widespread fallacy, the American political pundit Rush Limbaugh attacked evolutionary thinking in the wake of the 2016 Cincinnati zoo tragedy (where the gorilla Harambe was shot and killed to protect a child who had fallen into the gorilla pit). Limbaugh remarked: "A lot of people think that we all used to be gorillas, and they are looking for the missing link out there... they think we were originally apes... If we were the original apes, then how come Harambe is still an ape, and how come he didn't become one of us?" These remarks were subjected to widespread derision, with liberal press sources such as the Huffington Post (Mazza 2016) excoriating the conservative Limbaugh for his supposed ignorance of evolutionary theory.

In fairness to Limbaugh, however, he in fact criticizes an important variant of evolutionary theory that holds that evolutionary change occurs by anagenesis. According to Wikipedia: "Anagenesis, also known as "phyletic transformation", is when the new morphospecies is a result of rapid evolution in the ancestral form without speciation taking place, such that there are no remaining other populations of the ancestor species and the species can be considered extinct. The ancestor species is therefore superseded by the new species it morphs into." In Limbaugh's view, phyletic transformation should have transformed the great ape lineage, in its entirety, into humans, thus leading to phyletic extinction of the gorilla. This is of course an incorrect view of how evolution works, as it ignores the widespread evidence for cladogenesis or branching speciation. Limbaugh sets up and