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## A New Approach to The Logical Theory of Living Systems

Let us begin with a mental experiment. We will assume a universe consisting of nothing but sounds, and a consciousness which is only aware of sounds and incapable of being aware of anything else, because there is nothing else in existence. This sound world we shall call a contexture, and the awareness of it a system of contextuality. A life existing in such a world might be a sequence of beautiful melodies interrupted by shrill dissonances. The concatenations of sounds which we call melodies we will name single contexts in contrast to the all-enveloping contexture of sound in general. The strange thing is that a conscious life existing in this world would paradoxically never know what 'sound' is because there would be nothing it could compare with sound. And we know things only by their differences from other things. Now let us assume another world which consists only of tastes like sweet, sour, bitter etc. and a consciousness whose life would exhaust itself completely in the awareness of different tastes. Again we could not explain to a consciousness living in this taste world what 'taste' is because taste is everything it knows. And these two worlds could not know anything of each other; a consciousness of mere tastes could never conceive what sound is, nor could a consciousness of nothing but sound understand if we talk to it about taste. Both are imprisoned in their respective contexturalities. Let us call these simple one-dimensional worlds elementary contextures.

However, there may be an creature that knows both taste and sound and can compare them from the vantage point of what we may call a compound contexture that comprises taste and sound. This creature would also have its world which for itself is an elementary contexture from which it cannot escape and outside which it cannot conceive anything in rational terms. In other words: what would be a compound contexture relative to taste or sound would be an elementary contexture relative to a level of consciousness that can compare isolated sound and taste within a more complex sound-taste world.

It cannot be too strongly emphasized that the distinction between elementary contexture and compound contexture is relative. And since we know from biological experience in the animal and human world that it is a place where we encounter organisms of ever increasing complexities capable of supporting systems of consciousness of steadily growing scope of awareness, we may say that the contextures we have been speaking of form a hierarchy such that every given contexture will be a compound contexture relative to the contextures below it but an elementary contexture relative to those above it.

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We shall now ask which is the contexture of greatest reach that the human consciousness can encompass. It is designated by the ontological term of Being-in-general. To be or not to be, that is the basic question – which means that nothing outside of Being or beyond it is conceivable to us. And exactly like the consciousness which lived in a world of mere sound and could therefore never conceive what a sound is, we do not know what Being is and how it ever came about, since there is nothing we can compare it with. The world in which we live is to us an elementary contexture because all the variegated properties of individual contexts are held in this encompassing universal contexture of Being-in-general. Nevertheless there is something excluded from it, namely a consciousness which conceives the totality of this world of objective Being which appears in our judgment as an elementary contexture.

This, of course, raises the question: where does this seemingly ultimate consciousness originate that conceives the existing world as a whole? The classic tradition of philosophy has an answer for it and so have the great world religions. Permit me to remind you of the answer as it is given in Plato's Dialogue Phaidon. Socrates has been condemned to death and explains to his friends who are keeping him company during his last hours that he is not afraid to die, for the human soul which is the ultimate subject of cognizance is nothing but a temporary guest in this world. It enters this vale of tears at the time of birth and leaves the world again when the body dies. There is – so religious belief insists – outside of the total contexture of this empirical universe an unconceivable and unfathomable Beyond which is the home of the soul and of Life Eternal. The nature of this realm is not comprehensible in rational terms and only the longing for a better and higher world can reach out to it.

This, of course, is mere mythology for the scientist and rational thinker, although it is a beautiful one. But there is a tiny rational core in it which we shall now divest of its irrational adornments provided by our emotions. It is the age-old wisdom that Life is an phenomenon which is – as we shall call it – trans- or discontextural. It always transcends that which is objectively given. It is the basic difference between inanimate and merely objective systems on one side, and of living, subjectivity-endowed entities on the other side, that the first category, namely that of inanimate objects can always be described in the logical terms of an elementary contextuality; whereas living systems remain basically discontextural. It is an object; but it is also something utterly and inconceivably different from an object. There is no way to describe it as a contextural unit of thingness. We might say: it is a composition of different realms of merely potential objectivity where the actual objectivity of a specific domain may exclude the actualisation of another domain. The objectivity of – let us say – our human flesh and blood belongs to a different contexture than the subjectivity of the thoughts and concepts which our living awareness produces. And yet, what we perceive a mere subjectivity may be objective in a contexture of a higher order. Thus subject and object – although mutually discontextural – may belong to one and the same poly-contextural world. But the old distinction between body and soul is only a very crude example of the discontexturalities that pervade a living system. An organism is always a compound of a multitude of single contextures that are discontextural relative to each other. The functioning of the neurons of our brain belongs to a different contexture from that of the chemical processes inherent in our blood circulation. And these again are contexturally different from the mechanical activities of our muscles.

These general remarks should be sufficient to give a first, although a very vague thinking of what is meant by the terms contexture and contextuality. In order to be somewhat more precise let us now turn to a formal logical definition of contexture. A contexture is a logical domain which may be exhaustively described by the laws of two-valued logic. However, the application of these laws must be conducted in such general terms that the law of the Excluded Middle does not find a restricted application. Its validity must be universal. Normally we apply the law of the Excluded Middle in a non-universal and rather loose manner. If somebody says in a court of law: The defendant is either guilty or not guilty, it would be fictitious to remark: oh no – he is blond and broad shouldered. Which means that the alternative guilty or not guilty is confined to the isolated context of judicial concepts and excludes everything which does not belong to it. But a context, as we have pointed out before, is not a contexture. The contexture would include all those terms which the limited application of rule of the Excluded Middle prohibits. In the universal contexture the description of the defendant would indeed encompass such terms as blond, broad shouldered, married, sick and so on. The universal application of the law of the Excluded Middle would thus be an existential statement: The defendant is or exists as an embodiment of all these – practically infinite – properties which characterize his effective presence, or he is not. In other words: the universal application of the law of the Excluded Middle establishes the ultimate alternative between: something is or between something is not. In metaphysical terms: between Being and Nothingness. By having this effect the universal application of the Excluded Middle establishes the boundary of an elementary contexture. Because it is obvious that no description of what there is can continue beyond the limits of Being-in-general into the domain of Nothingness. Furthermore: since the two-valued logic defines the boundaries of a close contexture it excludes automatically that which is discontextural. And since discontextuality is the basic structural property of Life or Subjectivity, it means that a world described solely in terms of an two-valued logic provides us with the scientific picture of a subjectless universe.

This has been recognized many times. Permit me to quote just one outstanding scholar, the late physicist Erwin Schrödinger. In his Tarner lectures, delivered at Trinity College in the University of Cambridge, England, in 1959 and later on published as a monography titled 'Mind and Matter' Schrödinger remarked: "...our science – Greek science – is based on objectification, whereby it has out itself off from an adequate understanding of the Subject of Cognizance, of the Mind." (p.54 ff) And again Schrödinger: "Without being aware of it and without being rigorously systematic about it, we exclude the Subject of Cognizance from the domain of Nature that we endeavor to understand." (p.38) And finally, we find in the Tarner lectures the profound remark: "The reason, why our sentient percipient and thinking ego is met nowhere within our scientific world picture can easily indicated in seven words: because it is itself that world picture. It is identical with the whole and therefore cannot be contained in it as a part of it." (p.52)

Schrödinger's last statement illustrates in an excellent way what we meant by the distinction between two contextualities. First, the objective world itself as the sum of all things and their interlocking activities is conceived by us as a single contexture notwithstanding the fact that this environment of our is composed of an almost infinite amount of contextures of

lower order. Second, the image of this world as we produce it in our scientific theories belongs to a different contexture. And the only way in which according to Schrödinger the subject of cognizance can manifest itself to us, as long as we adhere to the habits of classic thinking, is the reflection of reality in our subjective concept of it. We become first aware of our subjectivity, by the fact that we have an image of our environment.

But two-valued classic logic defines – as we pointed out above – a single subjectivity represents a contexture of the lowest order. And since subjectivity of its own, it is automatically excluded from any two-valued theory of the universe we might have. On the other hand – and this is very confusing when first introduced to the theory of polycontextuality – taken as a single elementary contexture subjectivity must also be described by a two-valued logic and this logic in no way differs from the logic which we applied to perceive a subjectless universe. The point is, although it is in both cases the same logic and even the same technique of application, that it is of utmost importance we have to distinguish between the two applications. This means we must be able to state how they relate to each other.

The way to do so in precise structural terms is by introducing a multi-negational logic in such a way that this logic appears as a general place-value system for any number of two-valued logical structures. The places themselves which harbor such classic systems represent elementary contextualities. Each appearance of a two-valued logic within the place-value System defines a single contextuality and the relations which these two-valued systems display within a multi-negational order produce the structural phenomenon which we call Poly-Contextuality. A subjectless universe, conceived in terms of absolute objectivity is, ontologically speaking, mono-contextual. On the other hand, a cosmos which we describe as a region that contains life must be considered to be poly-contextual. And not only that: every part of such cosmos which we recognize as a living organism must also considered to be poly-contextual.

At this point an important question should be answered: Since our classic two-valued logic has furnished a solid foundation for our sciences for more than two thousand years and since these sciences have produced admirable results, why should we change this classic basis at the present juncture? The answer is: because since several decades we have been trying to develop a new scientific discipline, called cybernetics which does not only want to theorize in abstract terms about the phenomenon of Life but which has the ultimate aim of designing analogues to life processes in terms of physical systems. This ultimate aim of cybernetics is not always clearly understood by some scientific workers who call themselves cyberneticists, but it is positively implied in Norbert Wiener's famous work and in the researches of Warren S. McCulloch.

On the other hand, cybernetics is by no means the first scientific discipline to deal within the natural realm with the phenomenon of Life. But so far there has been no urgency to introduce new theories of logic into the field of biology proper. There is a good reason for it: although the term 'biological engineering' has frequently turned up in recent years there is a subtle but profound difference between the orthodox biologist and the engineer working in the field of cybernetics in general with special orientation towards biological computer theory. If a biologist works with amino-acids and protein molecules and experiments with

certain molecular configurations he does not pretend to produce Life in the laboratory by mechanisms of his own design, but he hopes that the modalities and capacities inherent in organic physical matter – if only combined in an appropriate way – will result in the emanation of life. But he himself, the biologist, will be merely the onlooker who observes what happens. In other words: the biologist intends to repeat, in a radically abbreviated manner, what our solar system did when it developed, in the course of cosmic history, from anorganic compounds into such material appearances as we call plants, animals and humans. The biologist follows basically the old homunculus theory of letting Life develop in the retort.

If the biologist ever succeeded, he would not be entitled to claim he had made Life, he could only take credit for having produced in a retort the necessary conditions to set in motion chemical processes that ended up in generating living matter. But this is not the way to obtain an answer to the question what Life really is. It would remain the secret of the inherent potentialities and powers of the material substance from which Life emerges.

The cyberneticist, in contrast to the attitude of the orthodox biologist, is guided by the epistemological principle of pragmatism that we only understand that which can make ourselves. In consequence, he does not want to be merely a more or less passive observer of the ways in which inanimate matter finally develops into living systems, but he wants to imitate as an engineer this phenomenon, or at least its functions, in a medium entirely of his own design. It is the medium we rather sloppily call hardware in cybernetics.

The scientific worker in this field will, of course, have to concede from the start, provided he is reasonable successful, that what he has produced is not Life per se (which is, at any rate, a metaphysical concept) but a specific mechanism which incorporate the various logical predicates necessary to analyze the phenomenon of Life. To put it differently: he will have succeeded in producing a machine which displays behavioral traits which we observe in living systems, but not in inanimate matter. Our cyberneticist may add: I do not know and, in fact, I do not care whether it would be possible to design a machine which is alive, but the mechanism I have produced, if perfect enough, might function in such way as if it were alive. And our cyberneticist might, furthermore, rightfully imply that he now understands what the term Life means up to the degree to which he was able to design behavioral traits of living bodies into his lifeless hardware.

It has been said that, when John von Neumann introduced memory into machines a new logical type of mechanism emerged. But we all know that the memory traits, so far displayed in cybernetic machines, cannot even remotely compare with the type of memory that the neurons of the animal or human brain produce.

The question is: would it be possible to improve memory in machines to such a degree that it would be practically indistinguishable from the memory capacities of a living brain in the higher species of animals? This author believes that the answer is in the affirmative but it cannot be done on the basis of mathematical theories based on classic two-valued logic. Because the universe itself as the producer of life has an ontological structure infinitely richer than anything that can be mapped by operations of classic logic.

Let us go back for a moment to the biologist who works according to the principles of the homunculus theory. His life is easier than that of the cyberneticist. If the latter wants to design biological computers, intending to imitate the activities of the universe in his machine, he must know the multi-negational code the universe uses when it is about to produce Life. But not so the orthodox biologist. In his case only the amino-acids, protein molecules and other chemical entities he works with have, so to speak, to 'know' multi-negational logic. Because they do their own engineering. He only observes and registers it. The biologist would, of course, understand better what is going on in plants and animals if he also had some knowledge of this type of logic but it is not absolutely necessary, because he can be experimentally very successful without really knowing what happens in his retort. But with the methods of orthodox biology he will never be able to give a satisfactory answer to the philosophical question: what is Life in contrast to Death?

Permit me to illustrate the limitations of traditional experimentally orientated biology with a peculiar property of biological system that has recently provoked widespread interest. I am referring to the surgical transplant organs from one living organism to another. So far medicine has not been very successful in this respect, since living systems tend to reject foreign tissue. It can be safely said that this would never be the case in a universe in which inanimate matter and living matter belonged to the same elementary contexture. But such a rejecting action will be inevitable in a poly-contextural universe. It is, of course, possible, and medicine is already working along this line, to reduce the rejective power of an organism by appropriate chemical treatment. And medicine may finally succeed in a more or less empirical method to reduce the rejective capacities of a given organism to such a degree that foreign organs may be transplanted for the normal lifetime of a patient. But that does by no means imply that the character of rejection is understood. It cannot be understood as long as our theoretical reasoning is exclusively guided by two-valued logic. In two-valued logic both values, so to speak, accept the contextuality within which they are active and which they represent alternatively. But as soon as we proceed to a multi-negational system with an indefinite number of values we become aware of a significant structural phenomenon. All values in such system can be divided into two basic categories, namely of either acceptance or rejection values. Let us say: we have a closed contextuality governed by two values, then both values will accept the specific alternatives governing the conditions of the contextuality to which they belong. However, if a third value is introduced in the confines of the aforementioned contexture it will produce a structural phenomenon which we interpret in logic as an antinomy or a paradox and which will appear within living tissue as a rejection function. Two different living persons are logically speaking compound contextualities which are mutually rejective.

One final remark should be made with regard to the number of contextualities which are embodied in the structure of our universe. The classic theory of reality assumes – as we pointed out above – that the world we live in is mono-contextural. Which means that all rational concepts and categories which we develop in our efforts to understand our environment belong to a simple system of two-valued logic which refers, if applied with unrestricted generality, to the ultimate background of all individual existence, namely to Being-in-general as contrasted with Nihilism or Nothingness.

In contrast to it the theory of multi-negational logic maintains that every individual datum or property of our universe plays the role of an intersection point of a theoretically unlimited number of separate two-valued systems of logic or – what is the same – of elementary contextures. The consequence is that wherever we logically connect any two data of our experience we shall discover that the relation between the two is governed by the laws of classic logic. This leads us easily to the erroneous idea that the universe as a totality can be conceived as a two-valued structure. And we are not shaken in this belief, even if we observe that whenever we can establish a two-valued relation between two data of our experience there is always a third datum which is excluded from the rational contexture in which the aforementioned relation is embedded. But instead of admitting that the structure of the universe is defined by multi-negational logic, we prefer to say that the eternally excluded Third is the index of the fact that our universe has a rational as well as an irrational component. And anything which does not fit into our solitary system of classic logic must be an irrational factor well beyond the limits of our traditional system of rationality which is and remains unique and single.

This is an tradition which this paper emphatically contradicts. We assert instead that any datum of experience which is excluded from a given two-valued system connecting logically two other data of experience belongs to another equally two-valued system which operates with sufficient independence from the first in order to make it distinguishable and relatively autonomous. But relative to such a second system of two-valuedness which repeats in a different contextuality the logical feature of the first there will be again a least one datum of experience which will be excluded from it as well as from the logical alternatives of the first. This leads to the stipulation of a third two-valued contexture and so on. Thus a trans-classic logic is basically nothing also but a theory of the interconnection of all single two-valued Systems which are required to find a contexture for any observable datum of the universe. In this very contexture our datum will be connected with some other datum.

Let us assume we have the data  $a$  and  $b$  connected by means of a two-valued logic within a contextuality which we shall call Alpha. And a third datum  $c$  shall be excluded from Alpha. Then there will be a second contextuality Beta which connects  $a$  and  $c$  in two-valued terms but now excludes  $b$ . Further there will also be a third contexture Gamma which in its turn will exclude  $a$ . It follows that wherever we look at reality in every single instance it offers us a two-valued face which leads us to believe that the total rational structure of the universe is two-valued and that we do not need a trans-classis many-valued, resp. many-negational logic.

The traditional classic thinker concedes that there is always something excluded from his rational world concept. But he interprets the continuous emergence of an exiled Third as the influx of a supra-natural Beyond which infuses this otherwise orderly mono-contextural cosmos with an element of irrationality. It is no wonder that the Greek thinkers – who conceived this two-valued and mono-contextural scientific world concept to which we still adhere – were deeply disturbed by the discovery of the irrational numbers. Their instinct told them that the two concepts of 'irrational' and 'number' did not fit together.

What the defender of the classic position is not aware of is the fact that it cannot be the same two-valuedness which he encounters at different ontologic locations of the universe. He is only right insofar as, wherever we isolate a objectivity devoid of all subjective finite sector of the universe as an objectivity components and consider such sector as a part separated from the totality of Being, it will always show us a two-valued and never a many-valued face. Absolute objectivity and two-valuedness are practically synonymous terms.

We shall add a final remark concerning the transition from the foregoing rather philosophical analysis to the technical question of how to develop a multi-negational logic which will give added precision to the theory of poly-contextuality. It is one of the most significant features of a trans-classic logic that it makes it almost impossible to maintain a strict division between natural number and logic concept. The reason is rather trivial. In classic logic we deal only with two values; one of them is designative, the other is non-designative. Thus only one value points to Reality and the role of the second exhausts itself in an auxiliary function. We simply need the second value to manipulate the designative value in logical operations. It follows that only one value represents, ontologically speaking, a number. But if only one number is available in terms of values, very little can be said about the connection of logic with natural numbers. An arithmetic with only one single natural number available will not carry us very far. It is highly significant that the connection between the arithmetical process of counting and logical structure is only made in a rather remote and rather problematic area of classic logic, namely in the so-called extended calculus of predicates. On the other hand if a multi-negational logic is introduced the number of values steadily increases and since a system with – let us say – 7 values shows remarkable differences from one of 20 values we can associate natural numbers with logical properties in a way which is not possible on the basis of classic two-valued logic. It is an association which remotely resembles the ancient Pythagorean ontology of numbers. And let us not forget the Pythagoreans developed their theory before Plato and Aristotle conceived the idea of a two-valued logic. Thus the theory of natural numbers becomes related to the poly-contextual concept of Life.

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