

Limitations of Scientific Ontology

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Abstract

Artificial life is a new multi-disciplinary science which is emerging from established practices in artificial intelligence, computational biology, and cybernetics. It is argued in this paper that conventional scientific concepts of being and existence, i.e. ontology, which underpin most of our attempts to create artificial life and intelligent systems, are inadequate to deal with these issues. It is argued that the current, pervasive and popular, positivistic philosophy of science is wholly inadequate when we come to deal with the issue of artificial life. However, by extending our ontological basis, specifically by incorporating a relativistic ontology (supporting a continuum of existence and being) we argue that the problem concerning the possibility of the creation of artificial life becomes tractable but not necessarily solvable. We argue that this approach lends itself to the development of usefully adaptive systems which can, in effect, simulate the intelligent (or cognitive) behaviour which we require of our systems, while not purporting them to be alive. An important ramification of this argument is the necessity of self-organization for effecting this development.

Keywords: Artificial Life, Ontology, Existence, Self-Organization, Philosophy of Science.

1 The context

Established endeavours in artificial intelligence and computational biology, together with the study of autonomous systems, have begun to coalesce and a new multi-disciplinary science, artificial life, is emerging. The ground upon which this new discipline is being built is, perhaps, not what it should be. It is argued in this paper that conventional scientific concepts of being and existence, which underpin most of our attempts to create artificial life and intelligent systems, are inadequate to deal with these issues. We take issue with the current philosophy of science which is rooted in common-sense, empirical and materialistic,

notions of what it is to exist. In spite of the fact that many scientists and philosophers do not hold such views (e.g. see [6]), the pervasive and popular paradigm of the mainstream of those involved in this endeavour is fundamentally one of positivism. So far, the results which have been achieved in artificial life to date (e.g. see [3, 4, 5]) are disappointing. We would argue that this is an inevitable consequence of the philosophy of science which has been adopted by the theoreticians and the practitioners of artificial life. While they would almost certainly counter that artificial life is an infant science and that, given time, the required results will emerge. Our contention is that it is not a question of time — although artificial intelligence, for example, is over thirty years old, it is no nearer producing a truly autonomous intelligent agent now that it was at its emergence as a discipline — it is a question of an appropriate philosophical basis to the science. Specifically, it is a question of the narrow and shallow conceptions of being and existence — ontology — which is an inevitable result of the pervasive world view. We wish to argue that, by extending our ontological basis, by incorporating a relativistic ontology (supporting a continuum of existence and being), the problem concerning the possibility of the creation of artificial life becomes tractable. We argue that this approach lends itself to the development of usefully adaptive systems which can, in effect, simulate the intelligent (or cognitive) behaviour which we require of our systems, while not purporting them to be alive. A sister paper develops this theme and argues in favour of a phenomenological methodology for dealing with the attendant organisational principles required of life-like systems while a subsequent paper will show that the standpoint being argued here subsumes the autopoietic organisational principles developed by Maturana and Varela[7, 10]. This latter paper will also discuss the requirements for the realisation of computational autopoiesis.

2 What is life?

First, let us attempt a definition. Chamber's Dictionary defines *life* as 'conscious existence; continued existence, validity, or activity of anything' And *existence*: 'to have an actual being; to live, to occur; to continue to live, especially in unfavourable circumstances.' *Being* is defined as 'existence, substance, essence, any person or thing existing'. Life, then, is intimately bound to the concept of existence and being and, thus, to ontology, 'the science that treats of the principles of pure being'.

One of the difficulties with these definitions is that the concept of life, though bound to existence, is some-what circular. Life is defined in terms of existence and existence, to an extent, in terms of life. One way into this circle is to deal, in a well-founded way, with existence and being. This is exactly the objective of this paper. Before continuing on that track, however, let us look at how some scientists attempt to look at the concept of life. Some of the key issues which

are raised in the endeavour to develop artificial life [3] include:

- the equivalence of the creation of artificial life with the development of systems that exhibit the same *behaviours* characteristic of natural living systems;
- the idea that this behaviour emerges ‘bottom-up’ and that the behaviour is not pre-specified.

The basic axiom of many endeavours to develop artificial life is that ‘living organisms are nothing more than complex biological machines’ and, implicitly, that these machines exhibit life-like behaviour.

The difficulty is that these treatments are essentially behaviouristic and are fraught with the same problems as befalls those involved in the current artificial intelligence debate where many (if not most) of the active researchers hold that a simulation of intelligence *is* an intelligent entity. This position is held irrespective of, and despite, the clearly different domains in which these two systems are instantiated. To postulate the existence of life of an entity, whatever about intelligence, on the basis of the appearance of its systemic behaviour is untenable; it avoids the central question and says nothing about the existence of life; it addresses only the appearance, the characteristics, of life. The question as to the independent existence of life is dodged.

Let us contrive an example to illustrate the problem. Consider a picture of a rose; a very high resolution colour photograph. A photograph with much greater resolution, spatial and spectral, than could be discerned by the human eye. Place it next to a real rose. Indeed, place it next to the rose of which it is a photograph. Now, it would *appear* that they are the same thing, wouldn’t it? No? You might argue: ‘Of course they’re not the same thing’. But you have no reason for saying such a thing, given that you make the distinction on the basis of visual appearance. The only thing that would allow you to make a distinction would be knowledge of, and observation of, the rose and its evolution, in time, out of 2-D space (or 3-D space if we deal with holograms). So, is it still a case of appearance, albeit that one has to admit an additional dimension to make the distinction (e.g. consider a micro-robotic simulation of a rose)? No, it is not: one can continue like this and never unearth the true nature of the distinction. But there is one, because we set up the scenario that way. Always, the simulated rose fails since it addresses *one* aspect of being a rose: its outward appearance and activity. It *is* not a rose because it is not constituted in the universe in the same form, of the same parts, interacting with and contributing to the (local) universe of which it is, itself, a part. The ontology of the two are different. Could the simulation ever be the rose? We see no reason why not, but we will defer that argument until we have covered the various perspectives on existence and ontology in a little more depth.

The position which we wish to argue here is that as long as we support a naïve dualistic view of existence (‘either it exists or it doesn’t’) then we cannot

make progress. We must allow for a more sophisticated world view, a more embracing ontology, i.e. a more elaborate conception of existence. We wish to argue in favour of a relativistic ontology, with a spectrum of existence: a scale of existence, ranging from the potential to the concrete with the gradation along the spectrum being marked by the level (or coherency) of organisation of that which exists. Life, then, exists at (and after) a critical point on this spectrum, i.e., at a critical point of organization. To begin the argument, let us look at how we come to have the conception of ontology — that of binary-valued being and existence — which is so pervasive and popular a world view.

3 Foundations of scientific ontology

Modern science emerged three hundred years ago from philosophy and, in particular, from what was then referred to as natural philosophy. Indeed, several scientific chairs in the older universities still retain the use of the term ‘natural philosophy’. It is unsurprising then that the axioms which underpin modern science have their roots in one or more of the several forms of natural philosophy which have been developed over the past three centuries. It would be folly to attempt an exhaustive treatment of the the history of the philosophy of science here but a representative thumbnail sketch is required.

To provide a relief against which to assimilate this overview and, indeed, to help identify the specific philosophical context which we are trying to draw out, we will first make some comments on the nature of reality. The concept of reality, as it is dealt with in philosophy is an old and hoary problem and there is a spectrum of philosophical positions which are commonly adopted. In a simple sense,¹ this spectrum is bounded at one end by *realism* and at the other end by *idealism*.

Realism is a doctrine which holds that the objects of our perceptions are what are real and that reality is what is directly perceived; it is through our perceptions that we apprehend the actual real external world. The tradition of modern realism has an impressive pedigree, beginning perhaps with Ockham (1285–1349) and continuing through Galileo (1564–1642), Hobbes (1588–1679), Locke (1632–1704), Hume (1711–1777), Moore (1873–1958), and Russell (1872–1970). Galileo, along with, e.g., Copernicus, Descartes, and Kepler, heralded the beginning of the scientific age which placed all empirical measurement and quantification along with rigorous mathematical (or logical) reasoning as the cornerstones for the construction of knowledge. This empiricist ethos was strengthened by John Locke, a quintessential realist, who held that reality is external and is perceived indirectly by the senses. Perception is conceived as a causal process whereby physical stimuli act on the sensory apparatus to produce ideas

¹Our endeavour here is less concerned with being faithful to each nuance of every philosophical position and more with caricaturing the situation to highlight the essence of these philosophical positions.

(or representations, in the modern parlance). Much of today's common understanding of ontology is a legacy of this Lockean frame of mind. It is interesting too that in Locke's philosophy we do not have *direct* apprehension of reality — only indirect ideas or representations of it and in this way he anticipated the conception of noumenology and phenomenology of later philosophers. In all realistic viewpoints, there is the underpinning assumption that reality exists — it is there — and, whether rationally by reason or empirically by sense, we apprehend it and thence come to understand its form and structure.

Realism is closely tied to the doctrines of *monism*, *materialism*, and *empiricism*; respectively the views that reality comprises just one substance; that reality comprises just one substance and that substance is matter; and that knowledge of the world is based on, and derived, exclusively from sensory experience. In fairness, the empiricist viewpoint is not as pejorative as it might appear for it says nothing about the *absolute* nature of that which is perceived.

Idealism, at the other end of the spectrum, is a doctrine which posits that reality is ultimately dependent on the mind and has no existence outside of it. In one sense, this doctrine denies absolutes since, without a single mind, there will be many subjective realities. Invoking God, as Berkeley did, gets us over this difficulty but at the expense of introducing a new, absolutely inaccessible, term. If Locke was the quintessential realist, then Berkeley was the quintessential idealist. Berkeley (1685–1753) developed, and subscribed to, the philosophy that nothing exists save that which is perceived by a mind. This is neatly summarized by his famous aphorism '*esse est percipi*' — to be is to be perceived — and, thus, the reality and existence of an entity is premised upon that entity being perceived (or perceiving). This is not to say that the entity 'vanishes' if it is no longer perceived nor that it is in some sense ethereal: the entity 'really' exists but Berkeley's position is that our idea about it are based on our perceptions of it. In this sense, Berkeley is also proposing an empirical point of view — that our knowledge of the world is gained exclusively from our senses. On the other hand, Berkeley denied the existence of matter: what exists is that which is perceived, and it exists because it is perceived. Reality pervades all perception but corporeal matter has no place in this scheme. This denial of the reality of matter is significant for it clearly distinguishes Berkeley's empirical idealist notions of perception from the realist, empirical, notion that perception is an abstraction or apprehension of the (material) world *via* a causal process of sensing.

Immanuel Kant (1724–1804) was also an idealist, but his views differed significantly from those of Berkeley. Kant differentiated between *noumena*, the domain of 'things in themselves' and *phenomena*, or the 'appearances' of things as they are presented to us by our senses. Kant argued that noumena are not accessible to us, and cannot be known directly, whereas the phenomena — the contact we have with these things via our senses and perceptions — are the basis for knowledge. Kant refers to noumena as 'transcendental objects' and his philosophy is sometimes referred to as 'transcendental idealism'. Thus, Kant

admits the ‘reality’ of a domain of objects, the unknowable noumenological domain. On the other hand, he maintains that the objects of our experience are the only knowable objects and it is the mind that shapes and forms these sense data and, hence, for us, these objects are the only objects that really exist and they exist *because* of us and our minds. Reality, then, exists as an unknowable, non-sensible, noumenal domain which gives rise to the phenomenal domain of our senses. Viewed in this light, Kant can also be seen as supporting a form of realism. This is significant as it is a position which has begun to be echoed in the work of current philosophers. In any event, the idealist tradition did not stop with Kant and has been added to by, e.g., Schopenhauer (1788–1860), Nietzsche (1844–1900), and Hegel (1770–1831).

There are many variations on these two themes of idealism and realism, perhaps the most famous of which is *dualism* which holds that reality comprises two distinct ‘substances’: one physical and one mental. To clear up any confusion we might remark here that realism and idealism are both monistic philosophies, i.e. reality is comprised of one ‘stuff’. Dualism, then, stands between and accepts something of both of these two extreme types of monism. Dualism was first propounded as a philosophical system by Rene Descartes (1591–1650) who argued for the existence of *two* domains of reality: one corporeal and one non-corporeal. Both mutually-exclusive domains exist concurrently. It is this mutual exclusivity which has caused dualism most of its problems for, if they are truly mutually exclusive, how can they interact? This difficulty has been transposed into modern philosophical debate as the so-called ‘mind-body’ problem. Here, one is faced with the problems posed by the premiss that there are two domains: one, the body, and the other, the mind. The body is the corporeal reality while the mind is the metaphor, or mechanism, depending on your standpoint, for non-corporeal reality. Again, we are presented with the obvious paradox that if these are mutually exclusive entities, then how do they ‘communicate’ as they most manifestly do?

Here, perhaps, it is pertinent to make a comment on the *popular* conception of dualism *vis a vis* the philosophical system of Descartes. In recent times, dualism has become a metaphor for representationalism: a world view which posits a polar distinction between object and subject — between perceived and perceiver — and, in a weak sense, between the real and the abstraction of the real (i.e. the representation). This is particularly true in modern Artificial Intelligence research where, utilizing information technology, models and simulations of so-called intelligent systems are constructed. Information technology systems routinely base all of their reasoning upon representations: data structures or internal abstractions of the information which is passed to it and extracted from it. We would like to argue here that this is a very bastardized view of dualism. Where, for example, *is* a data-structure in a computer? Where does it exist? It has *no* existence save that of the distribution of charge — electrons — in the electronic substrate that constitutes computer memories. In this case, representationalism, or bastardized dualism, has far more in common with Lockean

realism than it does with Cartesian dualism.

It might also be argued that true dualism, then, has a certain commonality (or parallel) with the noumenological and phenomenological positions of, e.g., Kant's philosophy, the corporeal corresponding to the phenomenal and the non-corporeal corresponding to the noumenal. But this is again a bastardized interpretation of these domains for it presupposes that noumena are, i.e. they exist, in 3-D space (or a 4-D space-time continuum) and, furthermore, that they are isomorphic with the phenomenological domain. This is quite contrary to the actual developments of Kant: noumena and phenomena are *not* dualistic and are not mutually exclusive.

In the above, we have attempted the impossible: to summarize five hundred years of philosophical thought in a few paragraphs. Nonetheless, from this cursory look at the history of western philosophy, it is clear that the philosophical positions on existence and being have been dominated by realism (including the bastardized version of dualism). Additionally, the philosophies that have been most closely aligned with the scientific method have also been those of realism. In a sense, neither of these observations are surprising since realism is the more immediately common-sense view: things exist — we perceive them. In the words of George Moore[8]: *I can prove now that two human hands exist. How? By holding up the two hands, and saying, as I make a certain gesture with the right hand, 'Here is one hand', and adding, as I make a certain gesture with the left hand, 'and here is the other'*. It is this common-sense intuition that underpins almost all of our common scientific enquiry, an enquiry which is almost entirely empirical in its investigation and rationalist, or mathematical, in its methodologies. It has given rise to an unquestioning mode of thought which has been copper-fastened this century by the logical positivists, e.g. Moritz Schlick (1882–1936) and Rudolf Carnap (1891-1970), who hold that reality is exactly that which yields to empirical investigation and anything that is not verifiable by empirical investigation is meaningless. We use the term 'scientific ontology' to symbolize this perspective on being and existence which has emerged amongst the scientific community as the popular and pervasive 'world view'. We are not arguing that this is necessarily the world-view held by contemporary philosophers (e.g. see [6]) or scientists (e.g. see [2]); rather, we are arguing that it is the pervasive paradigm of existence. Our contention is that this naïve position is very damaging for, just as natural philosophy evolved into modern science, modern science, in the guise of research in artificial intelligence and artificial life, is now carrying the torch of modern philosophy; perhaps not the philosophy of the professional philosopher but of the experimental philosopher. And, given that artificial intelligence and artificial life research has a far broader audience than does professional philosophy, any philosophical naïvity on the part of such scientists can only retard the advances we seek to make in developing, and disseminating, a vibrant and deep-seated understanding of what are fundamentally important philosophical issues.

4 Ramifications of scientific ontology

Given these positivistic scientific conceptions of existence, it is a paradoxical ramification that there is no escape from the conclusion that life, and organisation, do not exist in themselves and that in this context they have meaning only in our (human) cognitive domain. We have become accustomed to judging things solely by their appearance, that is by their behaviour: if you can't see it (with or without the aid of scientific instruments) then it doesn't exist. This accepted position is reductionist in the extreme: there exist, for example, only elementary particles or, equivalently, energy fields; reality comprises the constituents but says nothing of the organization of these constituents. We have thus painted ourselves into a very tight, realistic, corner, for it is clear that there *is* life. The problem then lies soundly in what it is we allow the term *existence* – ontology – to mean. If we stick with the conventional, current, interpretation, then we meet straightaway the reductionist paradox in an extreme form: the components of life are allowable (i.e. they exist), but not life itself.

Realistic positions suffer from the problem that all empirical knowledge is exactly that: sensed, perceived, and is thus acquired *indirectly*. It begs the question as to *what* really is being perceived. When we note that most of our modern scientific knowledge has been acquired indirectly using instruments, such as radio telescopes and electron microscopes, which augment our natural sensory apparatus, it is quite clear that our empirical knowledge is gained indirectly. Indeed, Wittgenstein (1889–1951), who had a profound influence on the development of logical positivism, in his later work argued that it is language which gives us our conceptions of reality, but ‘language is only the film on deep water’. In a remark in his earlier work, he notes [9] that there are things about which nothing can be said: ‘We feel that when *all possible* scientific questions have been answered, the problems of life remain completely untouched’. This is, at first sight, a defeatist position, in that it accepts that we cannot make progress on issues related to the true nature of reality and life. But only if we accept as final and ultimate our conventional scientific concepts and the popular scientific ontology.

5 Relativistic ontologies

There has, however, been a development in philosophical thinking, which begins with Kant's distinction between noumena and phenomena, and has evolved into a type of reconciliation of the idealist and the realist positions. It was developed by Edmund Husserl (1859–1938), who held that reality is personally and fundamentally phenomenological but is set against an objective spatio-temporal world. But it was best espoused by Martin Heidegger (1889–1976). Heidegger denied the dichotomy between the world and ‘us’ and saw existence or ‘being in the world’ as our activity in a constitutive domain. Reality does not exist

‘outside us’; we are beings in a world, not disjoint from it. It is this commonly-accepted disjointedness, this subject-object duality or polarity, which underpins conventional rationalist and empiricist understanding of science and which is the cause of so many of our philosophical problems. It is significant too that our language, with its subject-object structure, promulgates this mode of thought and understanding. What is real is experience and, in particular, our experience of being. What we perceive depends on what it is we are. This thesis is central to our development of a sound philosophical basis for a scientific investigation of the possibility of replicating (or synthesizing) artificially perceptive systems and artificial life.

Our dilemma in the foregoing discussion arose from the absolutely reductionist axiom of binary existence: Either it exists or it doesn’t; ‘it’ being the most irreducible entity (that we can currently conceive). The problem with this extreme reductionism is that, while it is all very well to reduce the macroscopic world to microscopic elements, if we are interested in composition, it renders impossible the endeavour to construct macroscopic entities of a higher order of organization from the microscopic: something is lost in the reduction. What is this something? There are those who would argue that this something was never there in the first place and that it was never lost. It is difficult to refute this claim if we accept that the domain of the reduced is all that there is. But at the same time, those who adopt such a position cannot account for the presence of emergent properties, the most pertinent example of which is life itself, nor can they adequately explain how these emergent properties arise.² The problem, again, lies firmly in the lap of our axiomatic acceptance of this reductionist ground — the paradox disappears once the axioms are questioned. If we allow a more relativistic position, that there are levels of existence, levels of being, then we have a way out of the paradox. What do we mean exactly by the terms ‘levels of existence’ and ‘levels of being’? We commonly associate a binary value with existence — either something exists or it doesn’t — and we do the same with the term ‘being’; it is or it isn’t. There is no middle ground. This is an unfortunate consequence of our realistic, materialistic, positivistic Western tradition. We wish to assert that the notion of a relativity of existence, a spectrum of existence, is useful; that is, there are degrees of reality. Some ‘things’ are more real than others. With this notion, the word ‘being’ now takes on a new richness, for we can speak of things with more, or less, being-in-the-world (*c.f.* Heidegger). That is, they and their context in the world, are more, or less, real. It follows that our perceptions, conceptions, and our experience of reality are contingent upon the level of one’s being in that world, i.e. the relative coherence or organization that we, as autonomous entities, have achieved on the

²Note, however, that there have been some very plausible attempts to explain life as spontaneously-arising instances of self-organizing dissipative systems, e.g., see the work of Babloyantz. We would not disagree with this stance, and the importance of the concept of self-organization will arise again later, but we would take exception with the position that it is the only issue involved.

ontological scale.

If there is a relativity in ontology, a spectrum of being and existence, then it follows that there is the *potential* for entities to have one or other levels of existence or being. That is, every entity has the potential to *be* at a given level. The potential which is currently manifested, we refer to as the ‘actualized’ state. Now organisation, the concept for which we heretofore had no ground, is at once well-founded: it is not a *thing*; it is an indicator on the scale of potential actualization: a position within a spectrum. Life, then, exists at (and after) a critical point on this spectrum, i.e., at a critical point of organization.

To continue the argument regarding the value of relativistic ontology and, indeed, to make it more substantial, we will introduce the natural philosophy of J. G. Bennett.

6 Bennett’s relativistic ontology

J.G. Bennett, in his *magnum opus*, ‘The Dramatic Universe’, propounded such a relativistic ontology. Bennett set himself the formidable task of constructing (or, rather, expressing) a new cosmology which embraces the central philosophical questions regarding the nature and reason for the existence of life but he set out to do it without neglecting any of the scientific knowledge or scientific principles that modern man has discovered and invented. Bennett also undertook that his cosmology would not be counter to common experience: thus, Bennett’s philosophy is grand in its scale and scope but local and pointed in its immediacy. He begins by asserting that one of the reasons we find ourselves in a quandary in attempting to deal with the obvious relevance and correctness of science and its equally obvious inadequacy in addressing *human* affairs is that it has become an endeavour solely concerned with *fact* and *knowledge* and has become divorced from *value*. Bennett’s work is a synthesis which re-asserts the importance of the *quale* while not usurping the place of the *quanta*.

Since we have begun each section so far, and the section on the history of philosophy in particular, by addressing the nature of existence, we should at least be consistent and do so again here. Bennett rejects the possibility of absolutes: absolute knowledge, absolute certainty, absolute truth. This in itself is a very fundamental (or devastating) act for, as he himself points out, much of human culture takes as axiomatic the possibility of the absolute and has been busily occupied in searching for this absolute. In science, this was true until the beginning of this century when it became clear that it was an unattainable goal. Bennett replaces the concept of absolute with a doctrine of uncertainty and relativity. In doing so, he renders ineffectual absolute rationalism (and logical positivism).

In developing his ontology, Bennett looked at the capacity of humans for apprehending reality. He indicated that a valid apprehension of reality must take into account

- the innate and universal presence of uncertainty;
- the inadequate perceptions of humans;
- the inability of humans to comprehend much that enters experience via our sense organs.

The third point may seem a little strange; the point is that our current popular positivistic and realistic world-view or paradigm fundamentally prejudices our experience of reality – we gain a biased view of things because of our shallow preconceptions.

Experience is taken as the only ‘given’ from which we can develop our understanding of reality. This might appear to be similar to the empirical point of view, either to, e.g., Berkeley’s empirical idealism or to the empiricism of logical positivism. Note well, though, that there is an important distinction, for sense perception is but one aspect of experience and this is central to Bennett’s philosophy. We will return shortly to this issue. For the present, let us continue in our treatment of sensory perception. Our perceptions arise from sensation through an ordering process that depends upon certain primary data being present in our experience. Bennett refers to *Categories*, immediate elements of experience having universal character, as the means by which our perceptions, our orderly picture of the world, is effected. The categories themselves form an ordered sequence, the position in the series being determined by the number of independent terms that a system must possess to exemplify that category. The categories begin with *wholeness* and continue through *polarity*, *relatedness*, *subsistence*, *potentiality*, *repetition*, and *structure*. Each of these require, respectively, one term, two terms, three terms, through to seven terms. The sequence does not stop at seven but continues and is limited only by our ability to comprehend the extraordinary increase in complexity that is brought about by the inclusion, or emergence, of an additional term. Indeed, the many monistic ontologies of naïve realism correspond to a one term system and a trivial level of comprehension of reality. Naïve dualism corresponds to a two term system and another level of understanding of reality.

Accepting, for the present, Bennett’s premiss that ‘What exists is the experience itself’, the question ‘Of what stuff is reality made?’ is exactly the same as the question ‘Of what stuff is experience made?’ Unfortunately, we are accustomed to thinking and talking about experience in dualistic terms: the object of perception and the subjective perception of it. This is reasonable if, and only if, we recognize that this limited view of perception and experience is the polar view and that there can be, indeed are, richer ways of looking at, thinking and talking about, experience (and, equivalently, reality). This will certainly require some fundamental changes in the manner in which we communicate such issues. At first blush, this identity of experience with reality is reminiscent of idealism but Bennett’s ‘idealism’ (if we can call it that) is fundamentally different from all of the idealist philosophies discussed in the previous section. It differs in

three key aspects: first, experience is not equivalent to sense perception – it is potentially much more than mere sense perception; second, Bennett’s ontology posits a continuum of reality and existence; and, third, there may well be things that are inexperiential and so we are not entitled to conclude that there is no reality beyond experience. Thus, Berkeley’s aphorism *esse est percipi* is not applicable.

Ultimately, then, reality is *not* homogeneous. It is identical with experience; not a poor experience such as sense perception, but a rich experience in that it encompasses all that is potentially experiential. Experience has three independent, but mutually relevant, aspects: functionality (facts and knowledge); being (the quality of the experience); and will (the intentionality in experience). Each of these stand in counterpoint to one another and thus the reality, or experience, is defined on a scale, dependent on the relative coherence of these three key elements. It is this coherence which we commonly refer to as organization, i.e., the scale of existence in this relativistic ontology is marked by the degree of organization exhibited by the existing entity. An organizational position or status which is premised upon the three elements of Function, Being, and Will. The nature of the organization can be expressed by the categories and by the number of terms which are necessary to exhibit that degree of organizational complexity. Clearly, there can be a ‘development’ of organization of an entity, i.e., a change in its existential status from the less to the more real (or vice versa). Thus, in every entity there is the latent (and real) potential for every existential status. Living systems are systems which have a particular degree of organization for which a particular number of terms are required before the requisite organizational complexity can be exhibited.

Hence, we have two issues:

1. The nature of experience with its infinitely more rich essence than what is commonly pre-supposed, involving the quantitative (fact/function/knowledge), the qualitative (being), and the intentional (will).
2. The domain of experience. Here we return to the noumenological and the phenomenological. Our experiences are phenomenological, the noumena represent the degree to which the phenomena are organizationally complete or ontologically complete: phenomena and noumena become identical when the entity experiences with full coherence of function, being, and will, i.e. as a total unity.

7 The conclusion

We can now squarely address the central theme of this paper: the possibility of artificial life. Is it possible to create artificial life? What is it possible to create? Is the endeavour worthwhile? We can now answer these questions and, in doing

so, we argue that there does exist a well-founded avenue for making progress and for simulating cognitive and intelligent systems.

To reiterate our position, life is a critical level of being, of existence, and consequently concerns the noumenal level of the universe (i.e. it requires not and is not contingent upon the phenomenology associated with humans). Organisation is an indicator on the scale of potential actualization.

Now, can we create artificial life? First, note that, given the above, we are dealing with the actualization of the ‘ground stuff’ of the universe, i.e. with the organization of the ‘matter of the universe’, *and not just with our perception of that matter*. Since we cannot (or, more correctly, do not normally) have direct experience of this reality — we experience a domain of phenomenology and not noumenology — then we cannot create, i.e. organise or actualise, existence and thus, we cannot create life. To create life, we ourselves would need to exist, to be and to do, directly in the domain of the noumena.

Recall the question we posed in the introduction regarding the possibility of the simulated rose ever being the rose. There is no reason why the simulation of the rose could not, in principle at least, be the rose. But it requires the inventor, the simulator, peer into the ontology of the rose, beyond his or her cognitive domain, beyond his or her phenomenology, into the noumena, and *then* arrange the simulation in *that* domain. Clearly, this mode of experience and work is not common to modern science.

On the other hand, can we create the conditions for life? Obviously, the answer, in a trite sense is: yes, for it is clear we can plant seeds from which life-forms grow. But that is not the question. Can we create the conditions for artificial life? In principle, yes; by facilitating the spontaneous *self*-organisation of the potential elements of reality. Since anything that we do, as humans, is done in our phenomenological domain, we cannot alter directly the noumena to bring about the required level of existence or being of an entity such that it is alive. All we can do is arrange the conditions whereby the existence of life arises for itself, elevating its own being, existence, and, since we identified organization as a point on a scale of being/existence, hence self-organizing. But such ‘arrangement of conditions’ requires that we reach beyond the phenomenology which is our experience and deal directly with the noumenology. This is difficult. Nonetheless, it is a valid goal, and one to which we must aspire.

And so, are all our everyday scientific endeavours doomed to failure? Absolutely not. Nothing in the foregoing argument precludes the *simulation* of life, by effecting the same principled organisation with the stuff of our phenomenology. And it should be clear by now that this is not the same thing as creating life. Nonetheless, we can work with the organizational principles which underpin the actualization. However, we can only do this if we have the right tools and if we know with what we should be working. Specifically, we need to be working with self-organization and we need a calculus or, at the very least, a methodology for reasoning about self-organization. We turn to the work of Bennett, Maturana, Varela, and Spencer-Brown to provide this framework; a

sister paper develops this theme and argues in favour of a phenomenological methodology for dealing with the attendant organisational principles required of life-like systems while in a later paper we will address the realization of a particular type of self-organizing system in a computational domain.

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