
September 30, 2008 · Book Review

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Abstract

Introduction

[YHVH says to all of you]:
‘Look, I am doing something new —
It is emerging right now,
Can’t you see it?
I am creating a path in the wilderness,
And rivers out of the desert.’

Isaiah 43:19:

I quote from the book of Isaiah to open this review because I see it as a counterpoint to Kauffman’s opening of his book with a poetic excerpt from the English metaphysical poet John Donne, a selection that strikes me as an exceedingly odd choice given that Donne’s poem not only involved a Trinitarian conception of God (a view of the sacred that Kauffman himself later repudiates, as we’ll see) but also an intense and paradoxical depiction of a clash between faith and reason. Yet, this latter theme just doesn’t mesh with Kauffman’s book since, rather than delving into any sort of spiritual crisis, it comes down squarely on the side of secular humanism with the little he actually does devote to faith and the sacred never rising above the banal, something that could certainly never be said of Donne’s poetry.

The above quote from Isaiah, in contrast, points to the possibility of there being a sacred source of emergent novelty, indeed this was the basis of an entire theological interpretation of emergence that was one of the most important trends in twentieth century theology, namely, the movement known as Process Theology based on the metaphysics of emergence expounded by the mathematician and philosopher Alfred North Whitehead in his magnum opus, Process and Reality (1979); a theology of emergence about which Kauffman has nary a word to say.

Because of my own high regard for Kauffman’s Origins of Order (1993), which had a deep influence on my own thinking about emergence and other complexity constructs, I wanted to give the current book an honest read, but that initial intention quickly devolved into a painful chore. Certainly, the sentiments seemed right and laudable: an ecologically-friendly “Green” Theology and one coming from complexity science and one of its gurus! This enticing prospect, though, quickly evaporated since what little this book actually has to say about the sacred/spirituality/morality turns out to be surprisingly sparse and mostly platitudinous. Instead, the greater part of the book is given over to musings on a variety of subjects, most of which will be easily recognizable as concerns Kauffman has dealt with in the past, but a few of which are new such as his theory of the quantum emergence about which Kauffman has nary a word to say.

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What kind of “sacred” is Kauffman talking about?

Although Kauffman's book purports to be about the sacred, this is the most arid and least interesting aspect of the book. Hoping to find insights from Kauffman about the sacred, coming from a perspective shaped by his long and vigorous study of complex systems, we come across, instead, statements concerning faith like the following: “As we see ourselves in a creative universe, biosphere, and culture, I hope that we will see ourselves in the world in a single framework of our entire humanity that spans all of human life, knowing, doing, understanding, and inventing. The word we need for how we our lives is faith, bigger by far than knowing or reckoning. A committed courage to get on with life anyway” (244). I’ll come back to this sentence shortly but here are some additional reflections on faith that never move out of the arena of platitudes (245ff):

- “we make the meaning of our lives, to live a good life, in all these ways”
- “Our choice is between life and death. If we choose life, we must live with faith and courage, forward, unknowing. To do so is the mandate of life itself in a partially lawless, co-constructing universe, biotic, and human world”
- “We can also choose to face this unknown using our full human responsibility, without appealing to a Creator God, even though we cannot know everything we need to know”
- “On contemplation, there is something sublime in this action in the face of uncertainty. Our faith and courage are, in fact, sacred—they are our persistent choice for life itself.”

In this context, Kauffman explicitly points to one of the sources which served as an “inspiration” for his thinking about faith, namely, certain credos he borrows from the Inter-denominational Center in Atlanta which includes such ditties as:

“LIFE FLOURISHES”

“RECONCILE WITH NATURE”

The use of capital letters for emphasis presumably expresses something about the purported profundity of these “faith” declarations. But, there is so little real content in such “credos”, it is hard to either agree or to take exception with them.

The nebulousness of such statements pervades Kauffman’s remarks on the sacred, to the point that the reader becomes thankful that he doesn’t wind-up spend much time on the sacred after all. If we go back to the first quotation in the first paragraph of this section, we already see evidence of this vagueness. What, for example, is this “single framework” about which he is talking? And what about the last word in the quotation “anyway”? Presumably this “anyway” refers to suffering in the world, a subject to which Kauffman’s supplies his own mini-reflections on, that is, what in theological circles is usually called the issue of “theodicy” which was so succinctly described by the poet and playwright Archibald McLeash in his play J.B.: if God is God, he is not good and if God is good, he is not God!
Here is Kauffman’s “resolution” of the issue of theodicy: “If we are inventing the sacred with ourselves as part of the real world, with all its wondrous creativity around us, then we have to come to terms with the fact that evil happens at our own hands, et al one for causes beyond our control.” Kauffman addresses the theme of atrocity by prefacing his remarks with an anecdote about how he once consulted with some generals in the Pentagon to share his research as if these meetings had somehow granted him some special sort of access into how atrocities can happen. And he ends this section with just another banality: “We are capable of atrocity... Surely, we should be as conscious of this as we can” (256). This is what he learned from the working with the Pentagon? One can’t help but ask, though, if he felt so strongly about our universal propensity for violence, why did he work for the Pentagon in the first place? And, just because he helped some generals make some kind of simplistic model of warfare, now he has special insight into theodicy?

Kauffman distinguishes between three classes of response to faith: those believing in what he calls an “Abrahamic” Creator God (I guess referring to Judaism, Christianity, and Islam all three of which religions claim the Biblical personage of Abraham as a forefather), Eastern religious traditions (Kauffman no doubt referring to such “spiritual” practices as yoga, meditation, and so forth), or secular humanists. But this tripartite division is so thin that even the briefest purview of the history of religions cannot but reveal a vastly richer set of possibilities for faith: from all the many different ways a creative deity has been understood; to the wide variety of polytheistic belief systems; to the equally multitudinous ways of belief and practice characterizing Eastern religions; and even to the great diversity of being a secular humanist.

Kauffman himself, as far as I can ascertain, would classify himself as a secular humanist. But that creates a problem right at the outset for secular humanism for the most part denies the whole existential or metaphysical category of the sacred, a problem that finds its most glaring expression in his very notion of “reinventing” the sacred. Indeed, the very word “sacred” is customarily used in “sacred” traditions to indicate something about transcendence, a quality entirely lacking in Kauffman’s book. Indeed, rather than finding any evidence of a Donnclash between faith and reason anywhere in this book, one finds more and more ill-defined restatements about a “courage to be” or “courage to live” in spite of…? I’m not sure what to fill-in here for “in spite of…”: in spite of atrocities, in spite of unpredictability, in spite of a whole host of painful aspects of being alive. This “courage to live” comes across as a watered-down version of Existentialism 101 combined with some kind of ungrounded “faith” in “progress.” Moreover, Kauffman writes about this “courage to be” as if made it up all on his own, completely ignoring the much deeper reflections on the relation of faith, the sacred, and the “courage to be” that were the centerpiece of the life work of the renowned Protestant theologian Paul Tillich.

Among what Kauffman calls the “Abrahamic” traditions, the original word for sacred in Hebrew (transliterated as “kadosh”) meant primarily separation from, thus emphasizing that the sacred is transcendent to or radically different than the profane, e.g., the Sabbath day is to be kept sacred or holy by being separated from the other six days of the week so that on the Sabbath day one refrains the work one performs on the other six days. Etymological dictionaries keep this sense of “separation from” in the Latinate words “consecrate” or “to remove from the everyday” as well as in the words “saint” and “sanctuary” for people and places apart from or transcending the normal mundanities of everyday life. This is why even Kauffman’s discourse about reinventing the sacred simply misses the point of the transcendent associations intimately involved with the meaning of “sacred.” I would claim that, by definition, if something can be invented and then reinvented, then it, by this same definition, cannot be sacred but must remain profane.

Of course the “Abrahamic” traditions don’t have a corner on transcendence — the sacred as a marker for transcendence also characterizes those “Eastern traditions” Kauffman mentions in passing. Consider, for example, the following words of the Buddha when describing Nirvana to his disciples, words about the path to enlightenment that are certainly considered “sacred” to Buddhists the world over, whether Zen or Tibetan or some heritage: “Oh, monks, there is an unborn, unarisen, and unconditioned. Were there not an unborn, unarisen, and unconditioned, there would be no escape for those born, arisen and conditioned. Because there is the unborn, unarisen, unconditioned, there is escape for those born, arisen, and conditioned” (from the Buddhist scripture Udana, see, Ther, No Date).

One sees transcendence as well in Buddhist approaches to the issue of suffering in the world, the “theodicy” of the “Abrahamic” traditions. In this regard, the story is told of a mother, grief stricken over the death of her child, who once came to Gautama Buddha begging him to bring her child back to life. The Buddha looked at her compassionately and said, “To heal your child I need a mustard seed from a home where death has never occurred.” This woman then went searching in every house in the village, but there was not a house where death had not occurred. It was from this shocking realization that the grieving mother took up the path of the Buddha dharma about impermanence and loss, a “theodicy” born from the personal experience of grief and compassion but also pointing to a transcendent resolution of suffering. Notice that in neither the “Abrahamic” nor the “Eastern” traditions is the sacred “reinvented” into some kind of vague “courage to be.”

What I find most surprising, though, about Kauffman’s remarks on the sacred is what I briefly brought up above, namely, their complete lack of reference to Process Theology (see, e.g., the journal Process Studies, one of the mainstream theological currents of the twentieth century that happened to have been founded on the very idea of emergence found at the core of Whitehead’s philosophy. Thus, Kauffman can proclaim: “Let God be our name for the creativity in the universe...”(232) and seemingly believe he is being original and profound whereas Whitehead and his Process Theologian followers had been saying things like that for nearly a century now and with much greater scope, cogency, and power. With Whitehead’s conceptualization of emergence as its foundation (Whitehead’s book Process and Reality was compiled from his Gifford Lectures of 1928-29, the
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does have the nice effect of elevating Kauffman to Penrose's celebrated status). It is interesting to note, by the way, that "With Penrose, I think it may instead be partially quantum mechanical" (204) (notice how putting his "I" into these sentences allows Kauffman to link his theory of consciousness to the quantum approach to consciousness put forward by Penrose (1990, 1996), a linkage that would elevate Kauffman's own theory to be on par with that of Penrose. That is why, in this context, Kauffman himself, in an uncharacteristic burst of humility, admits that decoherence "is still only partially understood" (208) but obviously this is no big deal for him since he shows no reservations in jumping right ahead with his theory of decoherence applied to mind.

The incoherence of decoherence

When it comes to his scientific in contrast to his theological forays, I wish I could report that Kauffman's new book fares better. But alas, I'm afraid these parts of the book should be considered even worse. Besides his claims for vast insight into genetics, evolutionary biology, economic theory, the origin of life, even the origin of the cosmos, Kauffman now, in Chapter 13, has veered into the highly perplexing arena of the study of consciousness with a theory of mind based on the quantum mechanical idea of decoherence. What this is supposed to have to do with the sacred which, after all, is what his book is purported to be about, escapes me although perhaps it boils down to: "there a mystery, here a mystery." That is, consciousness is mysterious and the sacred is mysterious so they must share something extremely important—but, of course, this is the specious logic of "ravens are black" and "anthracite coal is black", therefore "ravens are anthracite coal!" However, the relation of his decoherence theory of mind to the theme of the sacred is the least of Kauffman's worries in this chapter since, of far greater importance, is how incoherent, both scientifically and philosophically, his decoherence theory of consciousness turns out to be.

Decoherence is one of at least six alternative "resolutions" to the quandary of the so-called "quantum measurement problem" sometimes referred to as the problem of the wave collapse, or how the micro-world where quantum mechanics and its "weirdness" holds sway becomes the macro-world where the very different "classical" physical laws reign (see, e.g., Hartle, 1998; Penrose, 2004; Zeh, 1991). According to the renowned mathematical physicist Roger Penrose, other alternatives include: the Copenhagen Interpretation, mostly associated with Niels Bohr, which essentially downplays the need to understand what is "really" happening in favor of relying on the QM mathematical formalism itself; the "many worlds" interpretation offered by Hugh Everett; the "pilot wave" approach of David Bohm et al.; and a few other candidates. Penrose points out that each of these alternative "ontologies" addresses the apparent conflict between two fundamental quantum processes: "U" or the process described by the Schrödinger equation, that is, the state vector as controlled by a deterministic and continuous unfolding of a partial differential equation; and "R" or the phenomena of quantum state reduction when a "measurement" is made characterized by a seemingly discontinuous random jumping of the same state vector.

As a play on the term "coherence," the theory of "decoherence" contends that, whereas at the quantum level, the state of a quantum system possesses coherence through its property of superposition, at the classical level this coherence is so swamped by random and multitudinous environmental elements, it "decoheres" or, in other words, the coherent "wave collapses" or a "quantum state reduction" occurs. Penrose points out that at this decoherence stage, the mathematical construct of a "density matrix" is employed even though the exact ontology of the "density matrix" is never made clear, resulting in the situation that the theory "gives us no consistent ontology for physical reality" (Penrose, 2004: 810). Kauffman himself, in an uncharacteristic burst of humility, admits that decoherence "is still only partially understood" (208) but obviously this is no big deal for him since he shows no reservations in jumping right ahead with his theory of decoherence applied to mind.

Yet, right from the start, why should Kauffman have selected decoherence to be the cornerstone of his theory of consciousness, a rather surprising theoretical move since the idea of decoherence is not typically thought to be the most plausible of the current alternatives in explaining the quantum measurement problem or "paradox" (the latter term, according to Penrose, attributed to the Nobel laureate Tony Leggett). Moreover, decoherence, at least on first impression, would appear to have little to do with Kauffman's usual repertoire of complexity-based constructs.

I surmise, however, that by focusing on decoherence, Kauffman hopes to achieve two outcomes. The first is that decoherence allows Kauffman to link his theory of consciousness to the quantum approach to consciousness put forward by Penrose (1990, 1996), a linkage that would elevate Kauffman's own theory to be on par with that of Penrose. That is why, in this context, Kauffman can write: "Penrose and I both believe that consciousness depends on some very special physical system" (203), and "With Penrose, I think it may instead be partially quantum mechanical" (204) (notice how putting his "I" into these sentences does have the nice effect of elevating Kauffman to Penrose's celebrated status). It is interesting to note, by the way, that Kauffman nowhere indicates that Penrose's own quantum theory of consciousness, in spite of its dramatically impressive
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Senator William Proxmire's famous quote about government spending, what's a magnitude of a million here or a million there? second while neural events are a million times slower! So what if he's off by only a magnitude of a million? To paraphrase existence of such a poised state, Kauffman admits that chlorophyll's maintenance of a coherent state lasts only a trillionth of a quantum behavior" (213). He even mentions one physicist, without naming him or her, who says that sustained quantum natural selection has evolved this antenna to do just this sustaining of quantum coherence: as open thermodynamic systems in sustaining its coherent state against degradation into decoherence. Kauffman adds, in his by now characteristic fashion, that has a unique property of being able to maintain a coherent quantum state for 750 femtoseconds when it absorbs a photon of not, the chemical not, the chemical to the rescue, in spite of this unpropitious beginning, by offering as evidence for the existence of such a "poised" state, believe it or "open to research" (210) as well as that most physicists would rule it out, certainly at body temperature. Yet, Kauffman comes to coherence and classical decoherence while at the same time conceding both that the very possibility of such a poised state is the next phase of the decoherence theory involves Kauffman positing a hoped-for poised state existing between quantum coherence and classical decoherence while at the same time conceding both that the very possibility of such a poised state is "open to research" (210) as well as that most physicists would rule it out, certainly at body temperature. Yet, Kauffman comes to the rescue, in spite of this unpropitious beginning, by offering as evidence for the existence of such a "poised" state, believe it or not, the chemical chlorophyll. He puts forth chlorophyll at this juncture of his theory building since new research has shown it has a unique property of being able to maintain a coherent quantum state for 750 femtoseconds when it absorbs a photon of light energy and transforms it to chemical energy. Moreover, the antenna protein which holds chlorophyll has been shown to aid in sustaining its coherent state against degradation into decoherence. Kauffman adds, in his by now characteristic fashion, that natural selection has evolved this antenna to do just this sustaining of quantum coherence: as open thermodynamic systems into which matter and energy and information can flow, "cells may have evolved the ability to maintain coherent or near coherent [quantum] behavior" (213). He even mentions one physicist, without naming him or her, who says that sustained quantum behavior at body temperature is now no longer excluded. One does indeed wonder why this one physicist remains unnamed.

At the very same time, though, that evidence involving chlorophyll's coherence is employed to support his argument for the very existence of such a poised state, Kauffman admits that chlorophyll's maintenance of a coherent state lasts only a trillionth of a second while neural events are a million times slower! So what if he's off by only a magnitude of a million? To paraphrase Senator William Proxmire's famous quote about government spending, what's a magnitude of a million here or a million there?
Obviously not something that appears to worry Kauffman's "theoretical" effusions. And, of course, the "trifling" relevance of chlorophyll to mental functioning is never brought up at all. I guess we'll have to wait for the advent of a literally "green" brain science—forget about "brains in a vat" now we'll have "plants inside brains inside vats"! (Perhaps, a few dilithium crystals might help here and, for extra good theoretical measure, a dollop of tachyons!)

We haven't even gotten to how Kauffman conceives of the relevance of decoherence to consciousness. Somehow, it has something to do with the capability of coherence to perform quantum computations. By now, of course, we shouldn't be surprised that quantum computation is brought into the picture since it is just one more conceptually sexy idea that surely can be tailored to play a critical role in human consciousness. In this regard, Kauffman appeals to a recent theorem from quantum computing which involves building-in enough redundancy in a quantum computer that error correction can proceed, errors caused by those quantum qubits (the quantum computational analogue of bits in regular digital micro-chips) which begin to decohere before the computational work of the coherence stage, with its property of superposition, has been completed. It is just this redundancy which, according to Kauffman's interpretation of it, allows for partially decoherent degrees of freedom to reverse to fuller coherence. Thus, his theory of consciousness is not really based on decoherence per se but quantum coherence and its quantum computational capabilities.

From this arcane mathematical theorem from the arcane world of quantum computation (which, besides the most elementary of manipulation of qubits, doesn't even exist yet except as a set of highly speculative conjectures), Kauffman can then exclaim, "If so, a poised state persisting between 'largely' coherent and partially decoherent quantum variables looks possible" (212; his emphases) and, "... a poised quantum-classical mind system could process the entire set of sums and differences of the wave function, and tune the interference to increase the probabilities of good eventual classical behavior. The mind thus searches a vast space of possibilities to create a 'good' physical response" (214, 215). I presume the reader of this review is having a similar experience to what I had when I came across these sentences, namely, to feel totally befuddled. To what do "good" classical behavior and "good" physical response refer? How is this supposed "good" to come from processing "the entire set of sums and differences of the wave function"? What does processing "the entire set of sums and differences of the wave function" have to do with conscious experience? Or to sum up these befuddlements, why should some phantasmagoria of quantum computation have anything at all to do with human mentation?

Even if this "processing of the sums and differences" takes place only in coherence and not decoherence and thus really not in the poised state between them as he had first postulated, what exactly is this processing supposed to be for? It seems that Kauffman's theory of consciousness effectively comes down to understanding the human mind as a quantum computer. By the way, such a move renders his theory of mind an algorithmic one, albeit according to quantum computational algorithms as devised, for example, by the mathematician Peter Shor and others (Johnson, 2003). Yet, wasn't Kauffman supposed to have put himself in alliance with Roger Penrose's own quantum theory of mind which was essentially formulated to be non-algorithmic according to Penrose's appeal to the Gödel and Turing limitation theorems in mathematical logic? I guess this is just another "trifling" inconsistency.

Indeed, to shift back to the theme of the "reinventing the sacred" for a moment, what's being reinvented here is not the sacred (as we might have thought from the title of his book) but another vision of ourselves based on the machines we invent. We invent machines and then believe we function in the same manner as the machines we've invented. This is nothing new of course. When digital programming and computers first came along, the field of artificial intelligence got a tremendous boost as well as that view of cognitive science which became dominated by a striving to understand human intelligence and consciousness along the lines of digital computation. Now with quantum computation coming down the pike, I guess we'll have to brace ourselves for a similar phenomenon with quantum computation taking over from digital computation as the putative key to understanding human intelligence and consciousness. This, of course, neglects that the whole point behind even desiring to create quantum computers has had to do with their potentially breakthrough calculational abilities which are supposed to be provided by the property of quantum superposition. But why exactly does human thinking even in a miniscule amount resemble such a type of lightning calculating ability?

This is an issue that Kauffman never broaches. And, of course, neither does he bring in any actual neuroscience and those messy, wet neurons and synapses or any of the other recent, amazing discoveries about networks of neurons in the brain (see, e.g., Hagmann et al., 2008; thanks to Michael Lissack for bringing this article to my attention). Instead, Kauffman's decoherence theory of mind is a Rube Goldberg device cobbled together with this and that bit of theoretical flotsam and jetsam floating around in the conceptual Zeitgeist. If Kauffman actually thinks his less-than-a-scintilla-of-evidence-based decoherence theory of mind makes consciousness even an eensy-teeny more understandable, then I know a bridge I would like to sell him.

Kauffman's mentalist escapades are not over yet. As a further step in his argument, he resorts to that last refuge of all tottering conjectures, viz., that no physical law prevents there being molecular systems with a capacity for both maintaining their quantum coherence over long enough periods of time as well as possessing an ability for a recoherence of already decoherent states. No physical law prevents it? What kind of reason is that for supporting the veracity of a scientific theory? That no physical laws prevents it supports an incredibly enormous number of possibilities. For example, no physical laws prevent unicorns but it is not because physical laws don't prevent them that there are no unicorns. It's not just that there's too many "ifs" involved in his theory, it's that there are only "ifs" and not one brain mechanism, not one neural factor, not one neuron or sets of neurons, not one network of neurons is anywhere enlisted to aid in his theory of consciousness. Surely it was this kind of theory...
There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.

Indeed, it is because of the illusory investment of fact characterizing Kauffman’s theory of consciousness, that I have conjectured there is a hidden reason, which I briefly mentioned above, as to why Kauffman chose coherence/decoherence over alternative approaches to the quantum measurement paradox. This reason is that in his way of casting it, Kauffman’s “poised state” theory has the right conceptual structure of a threshold realm between two separate regions, a structure quite similar to his favorite notion of the “edge of chaos” whereas the other quantum measurement alternatives don’t come along with this kind of structure, certainly not the Copenhagen interpretation, or the pilot wave approach or the many worlds speculation. So let’s have a closer look at Kauffman’s adherence to the “edge of chaos.”

The “poised” quantum mind: The “edge of chaos” in new clothes

In Kauffman’s “poised state” between coherence and decoherence, we can read “poised” as “edge of” and replace “coherence” with “ordered” and “decoherence” with “chaos” and accordingly come up with a “poised state between coherence and decoherence” as a stand-in for “edge of chaos”. This supposed “poised state” theory of consciousness is then the latest outcropping of Kauffman’s fealty to the “edge of chaos,” his own “theory of everything” for marking where emergence is most probable and thereby the key to his contention that biological systems evolve to such a state.

To be sure, the “edge of chaos” is a theme that has dominated Kauffman’s work for quite a while now, a theme with which he has justified nearly all of his major speculations because of its supposed special capacities. Thus, in an earlier work, Kauffman (1996) wrote:

...on many fronts, life evolves toward a regime that is poised between order and chaos” (26): It is a very attractive hypothesis that natural selection achieves genetic regulatory networks that lie near the edge of chaos (26); ...life exists at the edge of chaos... It is almost spooky that such systems seem to coevolve to the regime at the edge of chaos (27); The best exploration of an evolutionary space occurs at a kind of phase transition between order and disorder...(27); ...as if by an invisible hand, the system may tune itself to the poised edge of chaos... (28).

This theme goes back at least to Stephen Wolfram’s (1994) early classification of the dynamics of cellular automata into separate zones of rigidly ordered, chaotic as in random, and complex. However, it was the speculations of the artificial life researcher Chris Langton (1990) with his ? parameter and the independent computational experiments of the physicist Norman Packard (1984; 1988) which lent the “edge of chaos” its purportedly deep significance, Kauffman falling in with those who eagerly glommed onto the idea.

What elevated this putatively potent state of the “edge of chaos” into such conceptual importance were the claims made by Langton and Packard that this particular threshold of dynamical behavior was especially powerful in generating complex as opposed to either ordered or random behavior, and that this region of complexity, by being a seed bed for the proliferation of emergent phenomena, was identified as possessing a pleroma of emergent computational capacity that was not to be found in either orderly ordered or overly random behavior observed in cellular automata. Kauffman, in fact, has been so enamored with this notion that he has repeatedly suggested that biological organisms have some innate propensity to evolve to such a state. Indeed, we saw a similar contention in the above discussion concerning how longer coherent states, e.g., in chlorophyll, are also supposed to be something towards which evolution evolves.

William James once wrote that the British philosopher of evolution Herbert Spencer’s idea of a tragedy was a fact meeting one of his theories. Similarly, Kauffman’s reliance on the “edge of chaos” has one itsy bitsy fact poking its way around inside his theoretical ointment, namely, that the original computational experiments on which the whole idea of the “edge of chaos” was founded on, those conducted by Langton and Packard, were subsequently found to be erroneous by other Santa Fe Institute affiliated scientists, Melanie Mitchell, James Crutchfield, and James Hraber (Mitchell, Crutchfield, and Hraber, 1999; Mitchell, Hraber, and Crutchfield, No Date). As far as I know, Kauffman has never addressed this countervailing evidence. But as he himself declares in the present book, he is not a Popperian when it comes to science, meaning that he doesn’t feel bound by the need to evaluate the soundness of a theory by the possibility of its falsification, a very convenient philosophy of science to adhere to when the evidence is simply not going your way!

Langton had claimed that as his statistic ? increased, the complexity of the dynamics increased with longer and longer transient phases eventually reaching a uniquely qualified “edge of chaos” region where the most complex, that is, the most non-periodic and non-random, behavior would occur. Along similar lines, Packard had used a genetic algorithm to evolve cellular automata to perform complex computations, contending he had identified a special “edge of chaos” where such a capability was supposed to be at its prime. In Packard’s case, he used cellular automata to perform an image processing task, turning to the so-called Kacs,
Kurdyomov, and Levin rule tables for a cellular automata. Packard interpreted his findings to imply that when complex computation (read: "complex emergence") is required, evolution selects rules that lead to a cognate "edge of chaos". It was this latter claim that presumably got Kauffman all fired-up since the fertile capabilities of the supposed "edge of chaos" were exactly what he was seeking for in his attempt to provide an alternative to strict Darwinian approaches to evolution.

But Mitchell, Crutchfield and Hraber replicated the early computational experiments of Langton and Packard and found the opposite, viz., that the cellular automata rules capable of performing complex computations, that is, the ones capable of producing complex emergent phenomena, were actually not to be found in the transitional locus of some "edge of chaos" between ordered and chaotic dynamics. These researchers pointed out that that an underlying assumption held by both Langton and Packard was that rule tables were the most important aspect of cellular automata behavior "in stark contrast" to state space and attractor basin aspects of dynamical systems. Yet, it is well-known that phase state behavior cannot be adequately parametrized by Langton's ?. Furthermore, whereas Langton and Packard presumed that the underlying averages converge, in point of fact they do not.

However, the most problematic assumption of Langton and Packard was that the supposed critical threshold of ? pointed toward the most fertile computational possibilities. Yet, Langton had not correlated ? with any independent measure of computation, an inadequacy that Packard, at least, tried to remedy. When Mitchell, Crutchfield, and Hraber performed an analogous computational experiment, they found that the rules for complex computation did not occur at some critical state of the ? statistic or the "edge of chaos" at all: "In summary, we conclude that there is no evidence for a generic relationship between ? and computational ability in CA and no evidence that an evolutionary process with computational capability as a fitness goal will preferentially select CAs at a special ? region" (Mitchell, Crutchfield, and Hraber, 1999: 11). On the contrary, they found that "independent of the population size a given run will be driven by and the population organized around the fit individuals that appear earliest." They even found that the supposed "phase transitional" regime in which symmetry was broken (following the construct of symmetry-breaking in phase transitions) was simply not the best realm for computational efficacy after all. Instead, computations performed better at symmetrical conditions. Indeed, Crutchfield, working with another colleague James Hanson (Hanson and Crutchfield, 1997), found that computational competence could be found in that dynamical region characterized as the "chaotic" class rather than the "edge of chaos" regime but that it might not be observed to do so because of deficiencies of the "filters" used in exploring the chaotic regime.

Now one might think that such countermanding evidence would lead, at the very least, to some caution when utilizing the "edge of chaos" or its analogues in theory building. This does not seem to be the case for Kaufmann, however. Perhaps he knows of problems or errors in the work of Crutchfield, Hanson, Hraber, and Mitchell which invalidate their findings and thus reaffirm Langton's and Packard's earlier conclusions. Although I haven't heard of anything like this, perhaps some reader of this review does know of such findings. If you do, please write to the editor.

Conclusion

As I mentioned above, countervailing evidence would not be of much concern to someone who repudiates the very idea of a Popperian approach to the philosophy of science. Indeed, in this book, Kaufmann not only repudiates Popper's concept of falsification, he proclaims his own approach to science as following the "holist" position proffered by the celebrated philosopher and logician Willard van Orman Quine. In Kauffman's interpretation of Quine's "holism," a scientific theory represents a whole world-view in which each element of the theory operates like words in a language so that there can never really be an adequate translation of, say, a poem from one language into another. Only completely "overwhelming" evidence would then count against one's theories, evidence so countervailing that a scientist's whole scientific worldview would have to be challenged. Of course, one can see a bit of Quinean "holism" in Thomas Kuhn's famous theory of scientific revolutions.

Moreover, by rejecting Popper and affirming Quine, or at least, Kaufmann's interpretation of Popper and Quine, turns out to be a pretty nifty position for a scientist to take, particularly one who is relying on shaky evidence. Also, it must be pointed out that Quine himself was not a scientist but a philosopher and a logician, and, furthermore, his "holism" was much more subtle and less encompassing than Kauffman's interpretation of it would have it. Indeed, seen through the lens of Quine's "holist" argument, we can understand Kauffman's commitment to the construct of the "edge of chaos", in spite of countervailing evidence, as a way to buttress his grander speculations about evolution taking place through a propensity to evolve towards some special realm of evolvability, an idea that teases with, but never quite goes the whole way, towards teleology. Eva Jablonska and Marion Lamb (Jablonska & Lamb, 2005), known for their theory of epigenetic inheritance systems, have pointed out that teleology, by turn, teases with bringing a "designer" back into evolution, exactly what the Darwinian approach to evolution was supposed to have elided from biological theory once and for all. One would think that by entering into such bold theoretical territory, Kaufmann ought to have some pretty solid evidence besides the shaky nature of the "edge of chaos" or its more recent stand-in of the "poised state" between coherence and decoherence.

Jablonska and Lamb have phrased the kind of theoretical stance, which we can interpret as what Kauffman is up to, as one where biological systems are characterized as evolving to a state where the ability to make evolutionary changes is more possibly realizable. An example they give is bacteria evolving to a condition where they can produce a burst of mutations when the going gets rough for their survival, e.g., MRSA, those nasty super bugs which are winning against our pharmaceutical
companies in the current antibiotic war. According to Jablonska and Lamb, this tendency for evolution to go in a specific direction which allows for the generation of "variations that could promote evolutionary change just when it's needed" (345) does seem to take place with various strains of *E. coli* bacteria that appear to respond to stresses like starvation by increasing their mutation rates and thereby generate more variations. Research has, in fact, revealed differences among the strains depending on which environments they were taken from, suggesting that this trait was indeed an evolved one.

However, Jablonska and Lamb warn that even these findings don't necessarily imply there is an evolutionary propensity to such a *telos*. Such teleological tendencies in evolutionary theory, according to Jablonska and Lamb, run counter to the accepted Darwinian contention that selection takes place on an individual, rather than on the group level or among lineages not individuals. Moreover, they point out that even if there really is selection by lineage and that those lineages that survive are the ones whose survival-benefitting variations help them survive, this still doesn't entail that variation-producing systems initially evolved to such an end or *telos*: "It is too easy to assume that because a particular aspect of an organism's biology promotes evolution, it evolved for this reason" (346). It is too easy because most mechanisms that promote evolutionary change through the promotion of variations, e.g., crossover in sexual reproduction, simply did not originate as adaptations to enable this greater evolvability but rather came about as by-products.

Of course, just because Kauffman is toying around with Darwinian heresy doesn't mean his speculations are indisputably wrong, but it does, in my opinion, render the theoretical situation facing him to be one where the burden of proof would weigh more heavily on his shoulders. Yet, he doesn't seem to see it that way but rather, it's as if the more outlandish, and I would add, the less cogent his speculations become, the more willing he seems to be in accepting very shaky evidence and proposals.

The science writer John Horgan (1997) was involved in several well-known debates during the mid-nineties with Stuart Kauffman and some other Santa Fe "chaocomplexologists." Horgan termed what Kauffman and his cohorts were up to as "ironic science" which Horgan believed was more like philosophy, theology, or art in addressing questions which were not answerable. "Ironic science," according to Horgan, proliferated ironic hypotheses which could never be demonstrated as literally true, e.g., questions like "why is there something and not nothing." Indeed, Kauffman had characterized his own approach as "Nothing's finished. I've only had a first glance at a bunch of things. I feel more like a howitzer shell piercing through wall after wall, leaving a mess behind. I feel that I'm rushing through topic after topic, trying to see where the end of the arc of the howitzer shell is, without knowing how to clean up anything on the way back" (Kauffman quoted in Waldrop, 1992: 300). For sure, maybe breaking new ground does include actions like a howitzer which of course literally does break new ground.

Nevertheless I fail to see how either his platitudinous approach to the sacred or his far-fetched, implausibly argued theories replete with extremely tenuous evidence can further scientific, philosophical, metaphysical or spiritual aims. It is one thing to think that perhaps Popper's falsification thesis is problematic in important respects, certainly many philosophers of science have argued quite cogently against it, but it is another to simply dispense with it and affirm in its stead a kind of Quinean "holism" when your reasoning is so manifestly faulty and the support on which you build your theories is so flimsy at best.

I realize that at times I have been sarcastic in my review of this book. I didn't start out in that direction, but along the way I became so flabbergasted at times that reading the book made me despair even about the entire publishing industry. Don't editors exist anymore? Or are they too interested in selling books through someone's often misplaced popularity that they just don't care if what they are publishing is simply not very good. Indeed, we've certainly seen a fair share of scandals in the publishing business because of the so-called true autobiographical "fictions."

I certainly have no personal animus directed at Kauffman. I've never even met the man. And, as I said at the outset, I have been very much influenced by his ideas on emergence, however I might disagree with this or that aspect of them. Nor am I personally or professionally opposed to speculation, even wild speculation, since I am becoming more and more convinced of a serious failure of the imagination on the part of many scientists and mathematicians. Indeed, again as I wrote above, Kauffman's chapters on anti-reductionism can be read as well-argued critiques of this same failure of the imagination. But what I am concerned about is how unfortunate it would be for readers, unfamiliar with the sciences of complex systems, to pick up this book because of the testimonials on the back cover and as a result of reading the book become convinced that, after all, this "chaocomplexology" stuff is really just a bunch of tripe dressed up in sophisticated terminology. That would be a real shame since I do believe that close study of the dynamics of complex systems and their fascinating properties of emergence do have significant, perhaps even profound implications for all sorts of philosophic, metaphysical, and spiritual matters (see, e.g., Russell, Murphy, and Peacocke, 2000). However, in my estimation, this is certainly not the book that will further such an agenda. Complexity theory deserves better than this.

References


