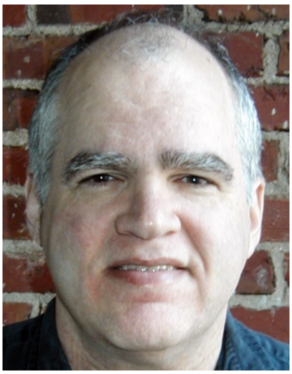
The Ontology of Generative Art, Information, and Universal Darwinism

Prof. Philip Galanter, BA, MFA.
Department of Visualization, Texas A&M University, College Station, Texas, USA
www.philpgalanter.com
e-mail: galanter@tamu.edu



Abstract

In digital generative art practice one of the most fecund methods is the use of genetic algorithms and evolutionary computing. This approach is inspired by the activity of DNA in living things, natural selection in the competition for survival, and the evolution of new species over time.

As used in generative art, the genetics and natural selection involved are typically considered metaphorical. In the virtual world of computation any notion of genes, and the material expression of genes, is ultimately a layer of abstraction that supervenes upon the underlying nonliving hardware consisting of binary memory bits, communication channels, central processing units, and so on.

In the biological world as described by Marcello Barbieri and others, the ontological status of genetic information is in dispute. The chemical paradigm presents life as an extremely complex system of chemistry, presenting a thoroughly materialist ontology. The information paradigm insists that along with the chemistry that is part of life, there is also an ontologically distinct notion of information to be found in the molecular sequencing and processing of DNA.

Barbieri suggests that the contrasting paradigms can be reconciled by noting that life is defined by its capacity to manufacture artifacts. Those supporting this view claim that the lack of evolution in systems of inorganic chemistry demonstrates the ontological primacy of information. This view, however, is directly opposed by the theory of universal Darwinism.

Universal Darwinism posits that complex systems can exist at multiple scales, and at each level of emergence some configurations will be more likely to survive than others. It is argued that the evolutionary process found in biology has parallels in systems as diverse as human language, memes (ideas), quantum mechanics, the neurology of brains, cultures, ethics, and so on. Universal

Darwinism tends towards materialism, treating information as description without ontological primacy.

This debate is offered to probe genetically based generative art. Considered is whether such art is indeed merely a simulation, or if it is an ontological peer to other processes of complexification that have created the universe we inhabit.

1. Generative art and complexification

In previous writing I've used complexity science, and in particular the notion of effective complexity, to contextualize generative art. [1] In this account various kinds of systems can be sorted from low disorder to high disorder, with the extremes considered to be simple systems, and those which blend order and disorder as being complex.

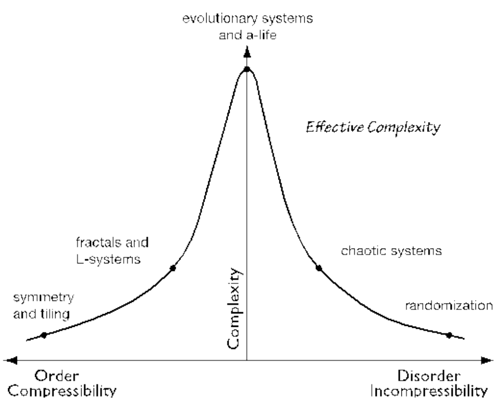


Figure 1 – Generative systems sorted by order and complexity

In digital generative art practice one of the most fecund methods is the use of genetic algorithms and evolutionary computing. This approach is inspired by the activity of DNA in living things, natural selection in the competition for survival, and the evolution of new species over time. The emergence of complex systems from precursors that initially seem much more simple is called complexification. [2]

1.1 Genetic evolutionary software systems as metaphors

As used in generative art, evolutionary systems simulate nature, and the genetics and natural selection involved are typically considered metaphorical. In the virtual world of computation any notion of genes, and the material expression of genes, is ultimately a layer of abstraction that supervenes upon the underlying nonliving hardware consisting of binary memory bits, communication channels, central processing units, and so on. Supervention here is intended in the philosophical sense where changes in an upper level are wholly dependent on changes in a lower level.

At whatever level of abstraction the software is conceived and written, it must ultimately be compiled down to machine instructions in order for the processor(s) to operate. The actual computation simulates individuals, environmental pressures, and most importantly, existence and survival. But any meaning is purely symbolic making reference to mental, rather than physical, objects.

So if an evolutionary system "creates" birds, there are no actual feathers involved, only the idea of feathers. Generative genetic systems don't create physical objects, they create descriptions of potential physical objects. Those descriptions can be used to render objects. But there is a category difference, which is to say an ontological distance, between the evolutionary computation and the implied physical object. To bridge this ontological gap there is an arbitrary semantic mapping of specific symbolic codes to potential physical objects for construction. It should not be surprising that this is similar to how we view language. We shouldn't view the results of simulated evolution as being ontologically equivalent to physical objects just as we don't view the word "bird" as being ontologically equivalent to a living, flying, bird.

2. DNA and information

In the biological world as described by Marcello Barbieri and others, the ontological status of genetic information is in dispute. [3] The ***chemical paradigm*** presents life as an extremely complex system of chemistry, presenting a thoroughly materialist ontology. The ***information paradigm*** insists that along with the chemistry that is part of life, there is also an ontologically strong and distinct notion of information to be found in the molecular sequencing and processing of DNA.

Many think of DNA as doing computation. It's not hard to see why. Genetic information at the lowest level can be viewed as a serial stream of nucleotides. Since there are only 4 nucleotides they might be viewed as super-bits that use a base-4 representation rather than a binary representation like typical bits in computer memory. Those nucleotides are processed serially producing the sequences of chemicals needed to create specific proteins. (This oversimplifies by leaving out the essential function of RNA, epigenetic effects, and a host of other complications.)

But these are superficial similarities and not matters of ontological significance. The genetic computation of generative art is metaphorical as it asserts that "This arrangement of bits means that amount of green." The particular mapping used doesn't matter nearly as much as the mapping being used consistently by all. The value of semantic information is limited by the social retention of the code used for its representation.

The representation in computer memory must be mapped into the mental objects we use when we think. This is what we mean by semantic information. Semantic information involves, by definition, a consistent but arbitrary mapping from symbolic representation to physical instantiation. Semantic information requires, in short, a code, a language, a mapping.

DNA is nothing like semantic information. It has no mapping from a symbolic representation to a meaning, or to a mental object. There is no code or language or mapping that has to be maintained by a society lest the meaning be lost. DNA doesn't require a society, but semantic information does.

What DNA does have is structure. It is constructed using a system of molecular sub-units used in various combinations. It is the very structure of the DNA, it's very physical nature as matter, that literally shapes congruent strips of assembled nucleotides. There is no coded semantic information. There is no conceptual mapping. There are only chemicals sculpting other chemicals.

In short, DNA is not an information system because there is no semantic content contingent on a mapping, code, or language. DNA does, however, have a physical material structure that operates as a very sophisticated form of chemical catalyst. DNA as material is sufficient for our understanding, and no appeal to information or computation is required.

Computation should not be confused with the objects that are simulated, any more than we confuse language for the objects they symbolize. The word "dog" is not a dog. And a dog simulated in software is not a dog.

Barbieri suggests that the contrasting paradigms can be reconciled by noting that life is defined by its capacity to manufacture artifacts. [3] Those supporting this view claim that the lack of evolution in systems of inorganic chemistry demonstrates the ontological primacy of information. This view, however, is directly opposed by the theory of universal Darwinism.

3. Universal Darwinism and complexification

Universal Darwinism posits that complex systems can exist at multiple scales, and at each level of emergence some configurations will be more likely to survive than others. It is argued that the evolutionary process found in biology has parallels in systems as diverse as human language, memes, quantum mechanics, the neurology of brains, cultures, ethics, and so on.

Maclaurin notes that Lewontin introduced three "Darwinian Principles" that must be in effect for any population undergoing natural selection. [4] These are:

1. Members of the population must vary from one another.
2. That variation must be heritable.
3. That variation must have effects on fitness.

At first glance it might be assumed that "heritability" here references genes and the mechanisms associated with DNA. And indeed that is the typical intent. But it can be argued that heritability is much broader than that specific instance, and comes from other additional sources. Various kinds of traits can be inherited as emergent properties in the process of complexification, including social behaviors, quantum effects, neurological processes, etc.

Wagner and Rosen argue that the biotic innovation offered by traditional Darwinian evolution parallels a universal Darwinian process of technological innovation found in industrial societies. [5] For example, both proceed in part by a process of trial-and-error. And both exhibit extinction and replacement. Both also draw from a possibility space to innovate via combinatorial exploration.

Universal Darwinism can be presented as compatible with radical materialism. The process of complexification is always scale specific. Smaller things are combined to create larger things. Via trial-and-error, some of those larger things survive longer than others. And some combinations may be so instable that they simply never exist at all.

This process of complexification can be viewed as Darwinism at multiple levels or regimes.

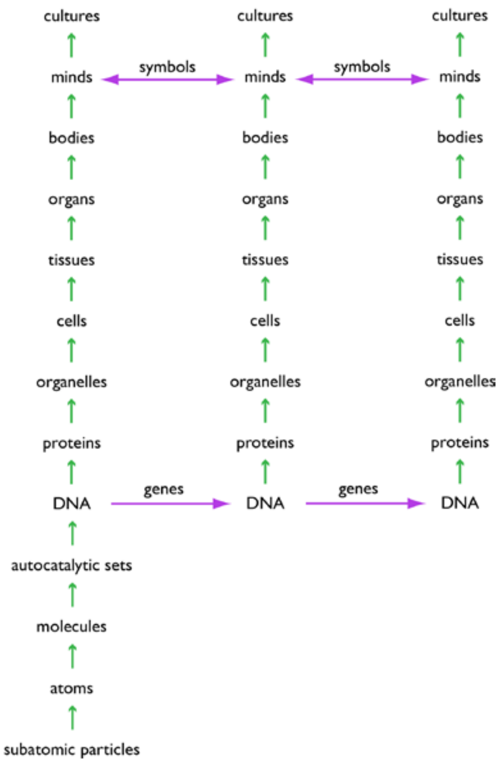


Figure 2 – Universal Darwinism creates scale-specific regimes that include the biotic, the abiotic, and even the social.

3.1 The emergence of regimes in universal Darwinism

One might wonder why there are so many levels of complexification corresponding to various absolute scales. Why isn't the universe more homogenized presenting only a single regime?

Regimes form in large part because objects have limited influence on other objects, and that influence drops off as a function of distance in space. That influence is typically nonlinear, and different kinds of influence will differ in their exponential degree.

At the subatomic scale the strong and weak forces dominate, and they drop off very quickly with distance. When too many subatomic particles are within atomic distance, the would-be atom being formed lacks sufficient forces to remain stable, and smaller atoms and free particles are released instead. The combinatorial creation of atoms in a cooling plasma of subatomic particles is a kind of trial-and-error process that seeks stability in the emergent objects. The atoms that exist are those that can persist. This is a kind of "survival of the fittest."

At human scale objects are in part limited in size and structure due to differences in the nonlinearities regarding mass and mechanical support. (Along with these ***scaling factors*** there are, of course, many other trade-offs in play as part of the genetic combinatorics.)

For example, the giant ants depicted in 1950's science fiction movies would be impossible under current known physics. The ability of the ant to support itself would be approximately proportional to the size of the (2D) cross section of its legs. But the mass of the ant is roughly proportional to its (3D) volume. As the ant is increased in size by some factor, its support increases as the square of that factor, but its mass increases as the cube. At some point the ant's mass increases so much faster than its support capacity that it is crushed by its own weight. Of course, real-world evolution would find compensations, and the legs of giant ants would be expected to adapt by thickening disproportionately. In this case the combinatorics involved are biotic and in the realm of DNA.

At Earth scale humans organize and associate through the exchange of symbols, ideas, and behaviours, thus forming cultures. Over time the extent of human communication has increased. Early man likely only knew about other nearby groups. Cultural competition and selection pressures were less varied than today where the industrial cultural interface is approaching all to all connectivity. But early man also made do with less material wealth and minimal technology, so their stress levels could likely have been much higher than those experienced in contemporary society.

Between finite combinations of factors, and differences in nonlinearities of influence, each regime takes shape. In terms ontology, however, there is no reason to assign some regimes with greater primacy than others.

4. Ontology and Generative Art

Taking a broad view, science tends to proceed via reductionism. This means that a given phenomenon is broken into components, and the phenomenon is explained in terms of the interactions of those components. Thus reductionism is, in part, a method of inquiry. Biology can be reduced to chemistry, and chemistry can be reduced to physics. But reductionism brings with it an ontological question. If a given regime supervenes upon a lower regime, does that mean the lower regime is of greater ontological significance?

In western philosophy, and indeed embedded in western languages, is the division of the world into nouns and verbs. There are things, and those things participate in activities. But there is an alternative. The ***process philosophy*** point of view unifies physical objects and their activities as processes. A process brings with it the notion that part of being is doing, and all processes do something by existing. Sometimes the doing qualifies as life, and sometimes not. And for all potential processes, some are going to be more stable than others. In process philosophy existence is not a property, it is a binary outcome of primary ontological significance.

Evolution in software is of lesser ontological significance. It is in the realm of symbols, representations, and abstractions that supervene on the existential drama of primary ontology.

Just because science proceeds via reductionism, that doesn't privilege lower levels of emergence as being ontologically prior to others. Every layer supervenes and is supervened upon. A cat's DNA is in no way "more real" than the cat itself. A subatomic particle is no more real than a star.

The analogy with ***object oriented ontology*** in this regard is both strong and beyond the scope of this paper. But in a way similar to what is suggested here, object oriented ontology tends to argue for a flat ontology, while allowing regimes of various scales and object types.

It's important to not be overly swayed by the apparent power computational generative art appears to provide. In fact, non-computational forms of generative art might be philosophically more rigorous. Generative systems of chemical art, bio-art, mechanical art, etc. are like DNA itself in that there is no distance between the generative mechanism and the existential fact.

REFERENCES

[1] Galanter, P. What is Generative Art? Complexity theory as a context for art theory. in International Conference on Generative Art. 2003. Milan, Italy: Generative Design Lab, Milan Polytechnic.

[2] Casti, J.L., Complexification : explaining a paradoxical world through the science of surprise. 1st ed. 1994, New York, NY: HarperCollins. xiv, 320 p.

[3] Barbieri, M., What is information? Philosophical Transactions: Mathematical, Physical and Engineering Sciences, 2016. 374(2063): p. 1-10.

[4] Maclaurin, J., Universal Darwinism: Its Scope and Limits, in Defensor Rationes: Essays in Honour of Colin Cheyne, J. Maclaurin, Editor. 2012, Springer.

[5] Wagner, A. and W. Rosen, Spaces of the possible: universal Darwinism and the wall between technological and biological innovation. Interface / Journal of the Royal Society interface, 2014. 11(97): p. 20131190-20131200.