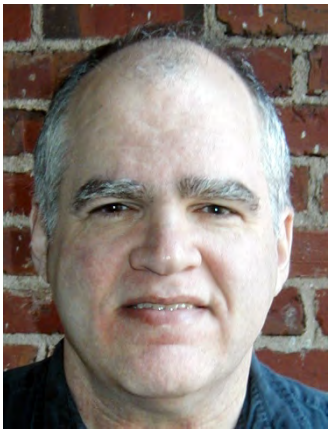
Philip Galanter

Paper: **Complexism and Generative Network Theory in the Arts and Humanities**



Topic: Art and Cultural Theory

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Main References:

[1] Galanter P:, "*What is Complexism? Generative Art and the Cultures of Science and the Humanities*", International Conference on Generative Art, Milan, Italy, Generative Design Lab, Milan Polytechnic; 2008.

[2] Galanter P:, "*Complexism and the Role of Evolutionary Art*" in *"The art of artificial evolution : a handbook on evolutionary art and music",* Springer, Berlin, 2008.

Abstract:

In previous writing I've traced how the systems-based nature of generative art leads to the application of complexity science, and how in turn that leads to the theory of complexism. Complexism is, in a sense, the projection of the world-view and attitude suggested by complexity theory into the problem space of the arts and humanities.

This paper extends the discussion of complexism with particular attention to generative networks, authorship, and the cultural circulation of ideas. Modern notions of heroic authorship, and postmodern notions such as the death of the author and deconstruction, are reconciled using modern network theory.

Brought into this speculative discussion are notions from network theory such as topology, metrics, preferential attachment, random attachment, node density, directed flow, order and disorder in small world networks, power laws, and emergent and scale-free networks.

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Keywords: Complexism, generative networks, art theory, cultural theory,

Complexism and Generative Network Theory in the Arts and Humanities

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Abstract

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This paper extends the discussion of complexism with particular attention to generative networks, authorship, and the cultural circulation of ideas. Modern notions of heroic authorship, and postmodern notions such as the death of the author and deconstruction, are reconciled in the context of modern network theory.

A critique of the failure of postmodern network theory, including the myth of the rhizome, is offered. In addition, a suggestion is made as to how a network-based view can help assign authorship to the programmer versus the computer in the case of digital generative art.

1. Introduction

In this paper I want to share some speculative thoughts regarding notions of authorship within the context of a philosophic and aesthetic view I've termed "complexism." While these ideas are somewhat tentative, they seem to be a natural extension of ideas leading up to this point, and provide an interesting frontier for further work.

Those encountering computer-based generative art for the first time often ask artists "who is the artist, the computer or you?" More sophisticated discussions of authorship are held captive by the faulty paradigms of the heroic modernist artist or the dead post-structural artist. The first question will be tentatively answered at the end of this paper, but first requires a discussion of network theory in the context of complexism. The latter question is first addressed in an on going attempt to subsume these incomplete contradictory models in an inclusive synthesis.

1.1 Background - Generative Art Theory and Complexism

In earlier writing I've offered a complexity-influenced theory of generative art that begins with the following definition:

> Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art. [1]

Given that the key element in generative art is the use of an external system, an understanding of system theory can illuminate generative art theory. The strongest contemporary body of system theory is that found in the interdisciplinary field of complexity science. In particular in previous writing I've leveraged the notion of "effective complexity" in sorting out various approaches to generative art. [2]

Previous notions of complexity, such as that in Shannon's information theory, have tended to equate complexity with disorder. For example, for the analysis of data delivered by an information channel, Shannon attributes the greatest complexity to random data. This follows from the notion that information that is difficult to compress is complex, and random data cannot be losslessly compressed at all. [3]

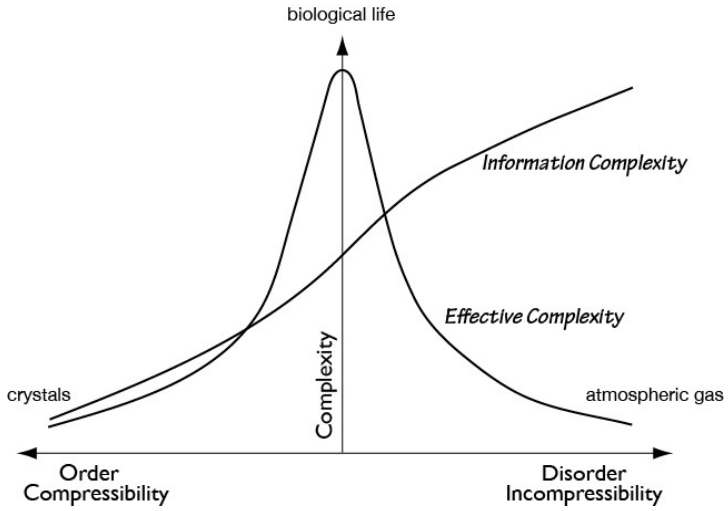

Figure 1 – A mix of order and disorder maximizes effective system complexity

Effective complexity attempts to capture and formalize a more intuitive sense of complexity. In nature we tend to associate maximal complexity with the realm of biology and living things. Simple systems seem to be of two kinds. First, first there are highly ordered systems such as the strict lattice structures of crystals. Second, and at the other extreme, there are highly disordered systems such as the molecules exhibiting Brownian motion in atmospheric gas. Both are, in their own way, relatively simple. Living things, however, exhibit both order and disorder. Order is required to maintain a degree of organic integrity, but a degree of disorder is required to allow for variation and adaptation. These two notions of complexity are illustrated in Figure 1.

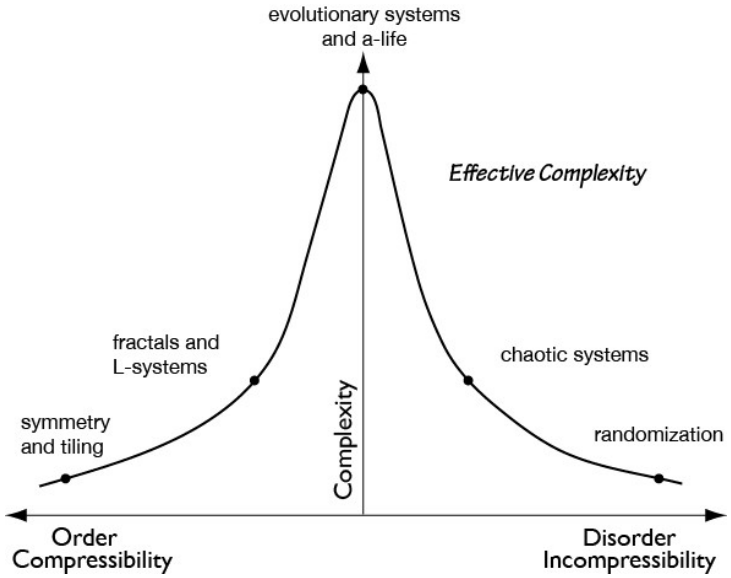

Figure 2 – Generative systems organized by effective complexity

In terms of a rough history of generative art progress tended to follow the general understanding of systems in the given culture. Simple highly ordered systems, such as grids, tiles, and symmetry, were the first systems exploited in the making of generative art. It wasn't until the 20th century that highly disordered systems were significantly used by generative artists such as John Cage and William Burroughs. However, in contemporary generative art it is primarily nature-inspired complex systems that are of greatest interest in the generative art community. This is illustrated above in Figure 2.

It's beyond the scope of this paper to provide an in depth presentation of complexism. However, complexism can be summarized in the table shown as Figure 3.

Modernism	Postmodernism	Complexism
Absolute	Relative	Distributed
Progress	Circulation	Emergence and Coevolution
Fixed	Random	Chaotic
Hierarchy	Collapse	Connectionist Networks
Authority	Contention	Feedback
Truth	No Truth	Statistical Truth Known to be Incomplete
The Author	The Reader	The Generative Network
Pro Formalism	Anti Formalism	Form as a Public Process Not Privilege

Figure 3 – Complexism as a thesis / antithesis / synthesis generated theory

The key idea is an extension of an idea first credited to C. P. Snow, and exercised with vigor in the so called "science wars" of the 1990's. [4, 5] I've previously described this conflict as a paradigmatic contradiction found when one compares the modern culture of science versus the postmodern culture of the humanities. Where the sciences posit real progress towards absolute knowledge, the humanities celebrate the circulation of ideas and relative knowledge. Where in science we find an

impulse towards the fixed and hierarchical, in the humanities there is the collapse of existing structures into arbitrary or “random” relations.

Complexism proposes to reconcile these apparent contradictions, and the various notions from complexity science shown in the chart hint how this is done. This paper focuses on the second to the last row dealing with theories of authorship.

1.2 Complex Systems as Networks and Process-based Ontology

Complex systems are those where a large number of agents or components have local interactions that result in emergent behavior at a higher level and larger scale. Traditional science proceeds in a reductionist manner. It is assumed that iteratively breaking phenomena down into component parts will provide insight. And indeed this is often the case. But what are lost are the holistic and emergent properties generated by mechanisms such as feedback, chaos, and self-organization. The lack of bottom-up models leaves much unexplained in pre-complexity traditional science.

In a sense complexity science encourages a move away from nouns and towards the greater inclusion of verbs. Rather than simplistically breaking big nouns into many little nouns, a new emphasis is placed on verbs as the interactions between those little nouns. This is made clearer if complex systems are modeled as networks. A network in this context is where components, the nodes, have local interactions that serve as links. (In standard graph theory nodes are called vertices and links are called edges.) The nodes are the nouns and the links are the verbs. So in the brain there are neurons viewed as nodes, and signaling viewed links. In an economy the entities possessing wealth are nodes, and the exchange of money, goods, and services are links. In an ant colony individual ants are nodes, and their use of pheromones serving as messages serve as links. And so on.

Ultimately networks only make sense as a fusion of nodes and links. Without links nodes cease being nodes. And without nodes there can be no links. This suggests an ontology based on process philosophy. Unlike the substance-oriented ontologies of the early Greeks, and the related traditional concepts carried forward in most western philosophy, being can instead be viewed as becoming or process. Networks exist as process where substance and activity, i.e. node and link, cannot be separated without both disappearing.

The interpretation of networks from a process philosophy point-of-view provides an ontological aspect to complexism.

1.3 Complexism and Theories of Authorship

In the conflict between the modern culture of science and the postmodern culture of the humanities I’ve noted that both tend to err towards oversimplification representative of their kind. Traditional reductionist science embraces highly ordered systems to a fault, just as the postmodern humanities embrace highly disordered systems to a fault. This can be seen in the modern and postmodern theories of authorship, and is especially apparent in 20th century art because it notably transitioned from modernity to postmodernity.

In modern art the focus is on the author working from a position of privilege in the heroic pursuit of totalizing masterworks. In modern art the audience receives the work as is and contributes little. But in the postmodern art world the post-structural take after Barthes is that “the author is dead.” What this means is that the work, the “text,” has its own independent existence. In fact the text has a kind of multiple existence in that it is instable and multivalent, and the audience creates meaning through deconstruction.

The view of authorship from the vantage point of complexism is closer to a “common sense” view of communication, but then builds from there to add new insights. A common view of authorship is that

three components are required; an author, a reader, and a text. What complexism adds is the observation that an author in one situation is a reader in another. This creates a network where reader/authors are the nodes and the texts are the links.

Once authorship is situated in a network-based model, the full range of network theory concepts can be brought into play.

2. The Failure of Postmodern / Post-structural Network Theory

Prior to the Copernican Revolution the dominant Ptolemaic geocentric model held that all heavenly bodies circled around the Earth. But the retrograde motion of some planets, i.e. their apparent occasional backwards motion, was difficult to square with the Ptolemaic paradigm. Those immersed in the Ptolemaic tradition, however, exhibited their own retrograde tendencies returning again and again to their comfort zone with increasingly arcane nested systems of epicycles within epicycles. It was complicated brilliant work. It was also incorrect. This intellectual retrograde delayed the ascension of the new Copernican heliocentric paradigm.

Today a new retrograde tendency is at work in the arts and humanities. For decades the comfortable models of postmodernism and post-structuralism have dominated the scene with a Ptolemaic-like presence. And too many humanists, having now been exposed to a potential Copernican Revolution of networks, complexity, and emergence, keep returning to their comfortable postmodern post-structural paradigm to retrofit these new ideas as epicycles within epicycles.

The philosopher Paul Cilliers is one of these. His book “Complexity and Postmodernism” offers an interpretation of neural connectionism as something already implicit in Derrida’s notions of traces and differences. But doing so exacts a great cost. In his view mental representation becomes recursive and unanchored, and our ability to create meaningful abstractions from empirical evidence is fatally eroded. Ultimately he questions the very practice of any network science when he says: “If something is really complex, it cannot be adequately described by means of a simple theory. Engaging with complexity entails engaging with specific complex systems.” [6]

Alexander R. Galloway in “Protocol: How Control Exists After Decentralization,” and with Eugene Thacker in “The Exploit: A Theory of Networks” offer a fundamentally political critique of computer networks. He points out that while the Internet is popularly viewed as a new decentralized and highly democratic medium, in fact it is a new form of highly efficient control by means of the technological protocols required. [7, 8]

Citing numerous philosophers, but most notably Foucault on power relations and Deleuze and his notion of control society, Galloway attempts to capture the new science of networks with the standard tropes of contemporary critical theory. But one must beware of those who ultimately only claim word games, lest they become caught in the epicycles within epicycles. Galloway seems all too comfortable rhetorically eliding from the control of checksums and packet routing to the implication of social control. And his worries about the social implications of object-oriented code encapsulation, and the need for political critique to be applied to algorithms, seem at best to be a form of what philosopher Gilbert Ryle has termed a category mistake.

This is not the first time that critical theorists in the humanities have sought to subsume science. As noted earlier the clash of the modernist-enlightenment values of science with the postmodern-skeptical values of the humanities came to a dramatic height with the Sokol Hoax and so called “science wars” of the 1990’s. Time has not been kind to the humanities field of science studies. And as even Cilliers notes, the entire postmodern post-structural enterprise is susceptible to the criticism that its highly corrosive skepticism and relativism undercuts its own ability to make any claims at all. This is what Jurgen Habermas has called a performative fallacy.

The application of science-based network paradigms, in their own Copernican right, is leading to novel and important findings in linguistics, literature, art history, anthropology, social behavior, and criticism. It is the humanists who insist on retrograde motion back to postmodern post-structural thinking that stand to miss out on the numerous theoretical, empirical, and mathematical insights afforded by the new science of complex networks.

2.1 The Myth of the Rhizome and Rise of Scale Free Networks

In it's original use the term "rhizome" refers to a plant structure. As a kind of horizontal shoot, rhizomes are sent out by a plant's root system. They will then terminate and create another rootstock, and with it a new vertical plant structure. Rhizomes provide an efficient way for plants to reproduce and spread.

In the realm of the arts and humanities the rhizome has become a popular metaphor for networks. This can be traced to Deleuze and Guattari's use in "A Thousand Plateaus: Capitalism and Schizophrenia." [9] It was intended to contrast with arboreal or treelike hierarchical structures, and also to offer a subversive structure that can infiltrate and overcome those same hierarchies.

It is this subversive nature of the rhizome that attracts the attention of the postmodern humanities. The possibility of destabilizing highly ordered structures resonates with the deconstruction of fixed meanings, and the radical equality of nodes supports the urge to collapse hierarchies and undermine authority.

With the introduction of the Internet, and especially the World Wide Web, into the culture of the humanities, there was an immediate identification of a "new" powerful communication technology with this socio-political agenda.

Translated into the kinds of topology found in network engineering and graph theory, trees are typically called star networks. They consist of a central node that branches off into secondary nodes, and these in turn branch off into tertiary nodes, and so on.

The precise topology of Deleuze and Guattari's rhizome is difficult to pin down because it is described in different, somewhat inconsistent, ways. It is most like what is known as a random graph in graph theory. A random graph is essentially a random network is created by iteratively linking randomly selected homogeneous nodes. The nodes are radically similar, and the links arbitrary and unpredictable. Investigated in depth by the prolific mathematician Paul Erdős with Alfréd Rényi, random graphs were once considered a natural stand-in for real world networks such as economies, the brain, metabolic and genetic biology, and so on.

But what scientists and mathematicians now know, and what has mostly been ignored in the humanities, is that random graph networks are rarely found in real world complex systems. In fact random graphs are now used as a kind of null hypothesis in network analysis. The network topology that is emergent in all manner of complex systems is called a "scale-free" network. Scale-free networks shorten the average distance between any two nodes by using central hubs, secondary hubs, and further lower-level hubs to create shortcuts. In a random graph such a journey requires visiting many intervening nodes. This is why airlines, for example, utilize hub airports for long flights, and then shorter legs to smaller local airports. [10, 11]

The number of links a given node has is called the "degree" of the node. In a random graph the distribution of node degrees is a Gaussian "bell curve." This shouldn't be terribly surprising given the random nature of its construction. The distribution of node degrees in the scale-free networks found in complex systems follow a power law curve.

Scale-free networks are found in complex systems such as social networks for friendship, collaboration, business, and notably co-authorship. Both the underlying physical and logical

structures of the Internet, as well as the link structure of the World Wide Web, are scale-free networks. All manner of economic networks self-organize into scale-free topologies, and the entire realm of biological networks, from large-scale ecologies to genetic, metabolic, and protein interaction networks are scale free.

In summary, the complex networks we refer to as being scale-free exist between the high order of hierarchical star networks and the high disorder of random networks. And the rhizome, once intended as an allegory, turns out to be mostly a myth.

3. Authorship in Generative Art

In a chapter in an upcoming volume I've described a number of problems in generative art theory. [12] These are not problems that require a single correct solution per se, but are questions artists, critics, and insightful audience members will want to consider.

> "It is notable that, for the most part, these problems equally apply to both digital and non-digital generative art; to generative art past, present, and future; and to ordered, disordered, and complex generative art. In addition, these same problems or questions are trivial, irrelevant, or nonsensical when asked in the context of non-generative art."

One of these questions was noted earlier, that concerning the problem of authorship in generative art. In traditional works literal authorship is trivial in that it is either a historical fact or at least a well-defined question for historical research. For many the insertion of the generative system between the artist and the artwork problematizes this simple relationship, and causes some to wonder whether the proximate cause, i.e. the computer or other system, should be credited with authorship.

Meanwhile, as was noted above, the model of authorship itself is also disputed. There is a conflict between the heroic author of modernity and the dead author of postmodern post-structuralism. Here it is suggested that the network model of authorship can illuminate both issues.

3.1 The Challenge of Inceptionism

Research software engineers at Google Inc. have created an image classification system using a very large database of over one million images and neural networks with unusually deep structures of 10-30 layers. The system delivers state-of-the-art computer vision capability in terms of being able to identify the content of previously unseen photographs. [13]

Of interest to this discussion however, and what caused an overnight sensation in social networking spaces inhabited by computer art practitioners, was a technique the Google team has termed "inceptionism."

Inceptionism uses a trained image recognition neural network to generate images. An initial image is presented to the neural network and it attempts to use pattern recognition to identify objects in the image. The neural network doesn't identify objects in a strictly binary found/not-found manner, but rather identifies areas with fuzzy probabilities, with lower layers identifying simple components like edges and shadows, and higher layers identifying more complex, composite, and abstract semantic features. Just as children might identify circus animals while looking at clouds, this system can "see" objects that aren't really there.

The trick is then to feed back the identified shapes into the original image by amplifying or modifying the given pixels in the direction of even stronger recognition. This is then done iteratively and with each step the image becomes more and more altered, and what the neural net "sees" visibly emerges in the image. If low levels of the neural network are used, then simple features like lines or patterns become exaggerated turning a photo into a kind of abstract art. If higher levels of the neural network are used actual objects appear like phantoms out of the ether. If, for example, the neural

network learned how to identify different kinds of animals, the technique of inceptionism will add dream-like animals to the image. These animals can take on a surreal look because the neural network will combine partial matches creating creatures like, for example, a bird with the head of a cat.

As an Internet meme the technology was first heralded as a breakthrough in artificial intelligence. The software was then made available to the public, and with its very specific look, it became something more like a new Photoshop filter. The challenge that interests us here, however, is how inceptionism can make us question our notions of authorship in the context of generative art.

3.2 Towards a Network Model of Authorship

Complexism suggests that authorship takes place in the context of a network of reader/authors passing texts back and forth. As noted previously this not only reconciles the modern and postmodern conflict regarding authorship, it also finds affirmation in studies of scale-free social networks for collaboration and attribution relationships.

Looking at a single author in such a network one can note the numerous incoming links for texts the author has read. These can be considered the influences the author draws from. Most generative art practice can be depicted in the network by inserting a computer between the author and reader. The generative artist/author creates a text that happens to be a computer program. The program is then used by the computer to generate the artwork sent on to the reader. The author has a large number of incoming links as influences. But the computer has a single incoming link, that being for the computer program that is an expression of the programmer's creativity and point of view.

But would such a diagram be an accurate depiction of inceptionism? After all the programmers created no code about animals, drawing, rules of composition, and so on. They created a system capable of learning patterns, but it was the neural network itself that learned from a million images what the world looks like. An honest network diagram would then show the computer as not having a single incoming link, but rather thousands and thousands of links for the images that were its influences.

What is suggested is that it is the attachment of links, rather than the ordering of nodes, that assigns authorship. Where many links lead to the programmer, and a single link leads to the computer, authorship of the generated artwork belongs to the programmer. But where many links lead to the computer, and the programmer is merely one of them, then authorship of the generated artwork belongs to the computer.

This need not seem strange. By analogy, we might credit Picasso's parents as being the "authors" of the young Pablo Picasso, but we would only credit Picasso himself as being the author of his works. The works are, in part, the result of the uncountable influences on Picasso offered by the world. In a similar way we might view the Google programmers as being the parents of the neural network system. The resulting artworks, however, are the results of the million and more images that served as the computer's influences.

It should finally be noted that this suggestion speaks to authorship but not creativity. An author can be creative to a greater or lesser extent. An author who merely compiles a phone book for a small town might be deemed to be entirely lacking in creativity. If we use the degree of incoming links to determine authorship, the analysis of creativity is a distinct and separate consideration.

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. Gell-Mann, M., *What is complexity?* Complexity – John Whiley and Sons, 1995. **1**(1): p. 16-19.
3. Shannon, C.E., *A mathematical theory of communication.* The Bell System Technical Journal, 1948. **27**(3): p. 379--423.
4. Snow, C.P., *The two cultures*. Canto ed. 1993, London ; New York: Cambridge University Press. lxxiii, 107 p.
5. Sokal, A.D. and J. Bricmont, *Fashionable nonsense : postmodern intellectuals' abuse of science*. 1998, New York: Picador USA. xiv, 300 p.
6. Cilliers, P., *Complexity and postmodernism : understanding complex systems*. 1998, London ; New York: Routledge. x, 156 p.
7. Galloway, A.R., *Protocol : how control exists after decentralization*. 2004, Cambridge, Mass.: MIT Press. xxvi, 260 p.
8. Galloway, A.R. and E. Thacker, *The exploit : a theory of networks*. 2007, Minneapolis: University of Minnesota Press. vii, 196 p.
9. Deleuze, G. and F.I. Guattari, *A thousand plateaus : capitalism and schizophrenia*. 1987, Minneapolis: University of Minnesota Press. xix, 610 p.
10. Barabási, A.-L.s., *Linked : how everything is connected to everything else and what it means for business, science, and everyday life*. 2014, New York: Basic Books. 294 pages.
11. Caldarelli, G. and M. Catanzaro, *Networks : a very short introduction*. 1st ed. Very short introductions. 2012, Oxford: Oxford University Press. xv, 122 p.
12. Galanter, P., *Generative Art Theory*, in *A Companion to Digital Art*, C. Paul, Editor. In Press 2014, Blackwell: Malden MA.
13. Mordvintsev, A., C. Olah , and M. Tyka, *Inceptionism: Going Deeper into Neural Networks*. 2015: Google Research Blog