Thoughts on Generative Art

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Abstract

I reflect on my mathematical art-making process and speculate on how it might relate to contemporary art practice. What does mathematical art represent and how does it relate to generative art? Is generative art a form of abstraction, illustration or realism? I use examples from my own work to guide the discussion.

Introduction

The term "generative art" usually applies to art in which the artist gives up some degree of control to an automated system. The system could be a mechanical drawing machine or a digital computer, or it could be a set of prescribed rules that the artist (or someone else) follows in producing the work. Galanter [1] defines generative art in the following way:

> 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.

As Galanter observes, generative art is a classification of process rather than of style, content or ideology. Thus, it does not constitute a movement in the way that, for example abstract expressionism does, but rather represents a tool that can be used in a wide variety of ways. Adopting Galanter's definition, generative art includes repetitive patterns, algorithmic art, many forms of op art, rule-based conceptual art, algorithmic music, computer-generated imagery (CGI), and, as we will see, many forms of mathematical art. Excellent reviews and discussions on generative art may be found in [1–5].

As an example of generative art, I present a few images of my own work (see Figures 1 and 2). These images were constructed using an ensemble of computational line-drawing agents that follow a set of rules outlined in [6]. The rules are meant to impressionistically simulate organic, flowing patterns found in nature and provide a framework for exploring autonomous mark-making. In isolation, the agents follow random-curvature walks producing graceful, elegant curves. When an agent encounters its own path or the path of another agent, it attempts to follow the new path. When an agent collides with a path, it stops. Agents can spawn new agents with a given probability. After the last agent has collided with a path, the process is complete and the drawing is finished. The process is stochastic, so even when the system parameters are identical, different patterns will emerge when different random number sequences are used.

Relationship between Mathematical Art and Generative Art

Mathematical art that involves computational methods or algorithmic renderings of mathematical objects is a form of generative art. When computer algorithms are employed, the computer "takes control" and executes the rules governing how shapes are rendered, musical notes are played, etc. Even if the artist hand-draws mathematical patterns or shapes using a procedural invention, she is still relinquishing control to the
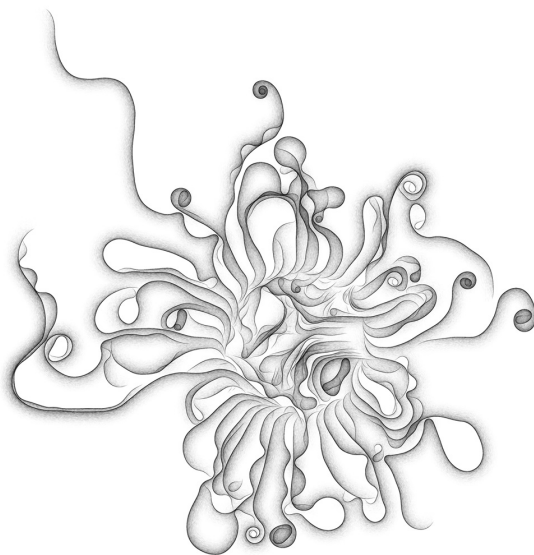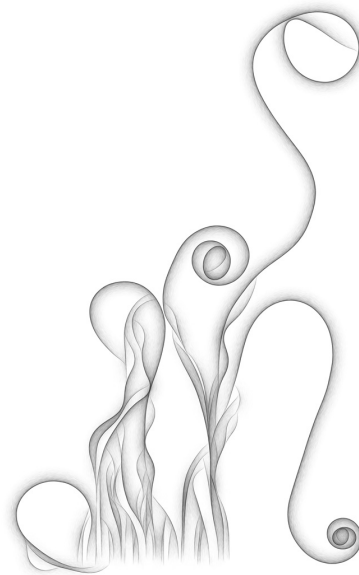
Figure 1: Flow #1.

Figure 2: Flow #2.

procedure, qualifying her work as generative art. Of course, some mathematical art references mathematics metaphorically and does not possess a generative quality (the visual poetry of Kazamier Maslanka is a fascinating example). Similarly, some generative art, while following a system, is not commonly thought of as mathematical per se (e.g. Sol LeWitt's famous wall drawings were rule-based, but not explicitly "about" mathematics).

While generative art is a category of process (which may or may not involve interesting mathematics), mathematical art is a broader idea that encompasses process and content. Also, mathematical art often (but not always) seems to focus on the properties of mathematical objects, while generative art almost always involves an evolutionary process that unfolds in time. The images presented in this paper, for example, were produced by a set of generative rules that evolved over time. Thus, while generative art and mathematical art share common ground, neither mathematical art nor generative art could be thought of as a subset of the other.

In the remainder of this essay, I focus on a subcategory of generative art in which computer algorithms are used to implement the autonomous rules. McCormack et al. [3] term this category generative computer art. Their observations that generative computer art poses a host of new questions not typically encountered in the art world inspired much of this essay.

Is Mathematical Art Abstract or Representational?

Generative art and mathematical art are remarkably effective at blurring the boundaries between abstraction and representation. Any mathematical object is inherently abstract. However, a detailed rendering of a mathematical object that is made to faithfully reproduce its properties might also be classified as being representational (it represents the form of the abstract, mathematical object). If the artist faithfully reproduces a mathematical object, then, even though the object itself is abstract, the artist is not necessarily participating in the act of abstraction. In traditional art practice, work that features geometrical objects is often character-
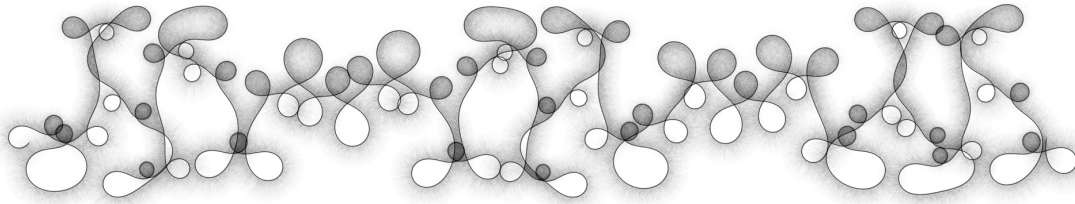
Figure 3: Sinuous meander pattern.

ized as being abstract, presumably because the artist is abstracting geometrical forms from the world around them to explore color interactions, composition, etc.

If abstraction is a process of selectively "taking from" nature to create a simpler, more fundamental representation of the world, then an artist who creates a visualization of an abstract mathematical concept works in the opposite direction. She starts with an abstract idea and reifies it by choosing colors, coordinate bases, etc. In other words she must "add to" the abstract object to render it visible. Thus, the classification of a particular work of mathematical art as being abstract could be viewed as being dependent on the artist's process, intent and starting point. An artist creating abstract forms from nature, experience, etc. actively engages in the process of abstraction, while an artist who creates visualizations of abstract mathematical forms might better be categorized as an illustrator or someone who engages in the process of reification. I propose the term "mathematical realism" to describe such work.

I'll briefly discuss one example from my own work. The image in Figure 3 is a design I call a sinuous meander pattern [7]. The image is a computer-generated rendering of a particular parametric curve most easily expressed in natural coordinates. Because the pattern accurately represents the curve, it might be classified as an example of illustration or mathematical realism. I was led to this particular form through reading the scientific work of a geomorphologist who used a simpler but related curve to model the meandering paths of streams and rivers. Thus, the image in Figure 3 might also be considered a form of abstraction because it references and "takes from" nature.

Is Generative Art Abstract or Representational?

As McCormack et al. observe, generative computer art often borrows ideas and methods from the simulation sciences in which computer simulations are used to model natural phenomena. Unlike simulations involving computer-generated imagery (CGI) where the intent is to create a life-like rendering of a scene, most artists who self-identify as generative artists do not "conceptualize their works as direct simulations of reality" [3]. Rather, they often create rule-based systems to explore pattern formation and the abstract relationship between the final visual artifact and the underlying evolutionary rules. I find this approach fascinating because it serves as a novel path to abstraction. Rather than create abstraction from the outward appearance of nature, generative art allows the artist to abstract from the underlying evolutionary processes that shape the world. Because the abstraction operates on a process, its affect on the final visual artifact is rarely intuitive and often surprising. The generative artist enters into a dialog with the abstract system much like a scientist. But rather than crafting rules that produce dynamics or forms that mimic nature, the generative artist often explores aesthetic or conceptual questions that arise from the process of autonomous mark-making.

Lessons from Photography

Throughout much of the twentieth century, photography struggled to define itself in relation to painting and other fine arts. Critics from Susan Sontag to John Berger proposed a variety of approaches to understanding the unique character of photographic art. Roland Barthes suggested that the power of photographs is tied to their poignant sense of loss and death: namely the death of the fleeting moment captured in a given photographic record. Barthes provides a framework for discussing photographs by introducing two concepts: the *studium* and the *punctum*. The *studium* is the social context, genre and narrative of the image that is available to all informed viewers. The greatness of the Apollo 11 photograph of the Earth rising above the moon is understandable through its *studium*. Barthes envisioned the *punctum* of a photograph as a "wounding" or "pricking" triggered by an *unintended* detail that instills an overwhelming personal connection with subject of the photograph. It is the unintended nature of the detail that opens a window into the world of the subject engendering it with an authenticity unmediated by the photographer. It connects the viewer with the subject directly, reassuring her that the image is not wholly constructed, but a document of a world that once was. In Barthes's language, the *studium* can cause the viewer to like a photograph, while the *punctum* can cause the viewer to love it.

I present Barthes's ideas of the *studium* and the *punctum* because I think some aspects of these ideas may be relevant to generative art. Like photography, generative art may be viewed as a window into a world that is both discovered and constructed by the artist. The generative system may be shaped by the artist through the modification of rules and parameters, but the emergent form is never completely predictable. The "*studium*" of generative art could be loosely defined as the mathematical context and rules defining the work. It could include mathematical predictions about the behavior, scaling or texture of the system. While *punctum* has layers of meaning specific to photography, I suggest that aspects of this idea might translate to generative art. One might broaden (and dilute) the meaning of *punctum* to include any unexpected or unintended detail that creates an emotional response in the viewer. I suggest that the allure of generative art lies in its capacity to create unexpected (i.e. whimsical, playful, organic, complex, etc.) forms from seemingly sterile mathematical rules. One looks at a generative piece and thinks "*that* was created from an algorithm?" The *punctum*-like response of surprise arises when the work functions on multiple levels that somehow goes beyond texture and pattern.

References

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