Self Portraits with Mandelbrot Genetics

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Abstract. This paper is an artist statement describing a manipulation of the Mandelbrot Set equation as the basis for creating semi-figurative images, using a genetic algorithm. Modernist painting is referenced in terms of the play between representation and abstraction. The Platonic implications of the Mandelbrot Set are considered as a point of departure for manipulation of the complex function.

Keywords: Mandelbrot Set, evolutionary art, genetic algorithm

1 Introduction

As a young art student, I had an appetite for abstract expressionism and surrealism. I would gaze at the paintings of Bacon, Motherwell, and Gorky, and marvel at their ability to mix beauty and ugliness, and force me to see the world more intensely. These artists explored forms that lay between representation and abstraction. I did not know that I was exercising my eye-brain for what lay ahead: a new art medium that would disrupt the existing paradigms of representation and abstraction.

Fig. 1. Four examples of self-portraits based on the Mandelbrot equation

The Mandelbrot Set is a curious discovery. It is as if a distant planet has been found. The intoxication caused by the Mandelbrot Set's fantastic, infinite form is offset by the simplicity of its genetic expression – these are two very different representations. The elegance of the Set's underlying code can lead Math-artists to lose the sense of irreverence that is sometimes necessary to pull a subject out of context and expand its expressivity.

When considered as a tool for visual expression, I believe the Mandelbrot equation has not yet been given a thorough workout, tweaked, deconstructed – using the tools of visual language. I decided that this would make an interesting challenge. The Set, so thoroughly complex and beautiful as to create near religious admiration – what a great candidate for the subversive act: The *Big Tweak*.

2 Process

The Mandelbrot-based images presented here are a recent variation from a series that has been evolving since the late 1980s. My personal vision of organic form, generated by way of genetic algorithms, has had its own evolution. The many thousands of images explored, discarded, and refined, constitute a Darwinian process of its own.

Introduced by Benoit Mandelbrot [1], the Mandelbrot equation is $z = z^2 + c$, where z and c are complex numbers, and c is a location in the complex plane being tested. The function is applied many times, with the output value of z from each iteration being used as input for the next iteration. During iteration, if the value of z exceeds a magnitude of 2, iteration halts, and the location c is declared outside of the Mandelbrot Set. Coloration of these two domains inside and outside the Set reveals an infinity of self-symmetry and filigree. Coloration, and adjusting the location and scaling in the complex plane constitutes much of what is called *fractal art*. The process I use involves altering the equation, inserting arbitrary real numbers (the *genes* of the image) into its code expression, as shown in Figure 2. I then employ a genetic algorithm to evolve families of images. I do not use color, and instead render the forms in sepia tones.
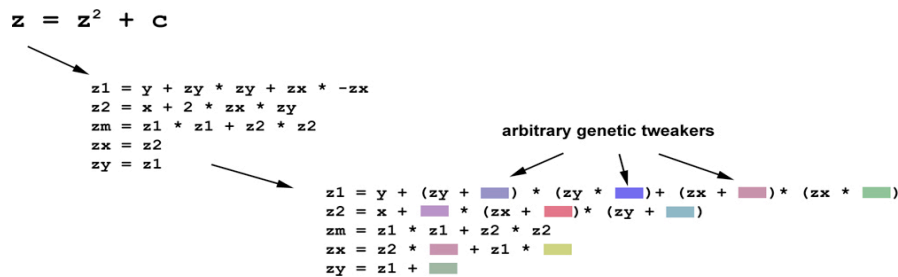
Fig. 2. Adding arbitrary genetic tweakers to the code expansion of the Mandelbrot equation

Yanking the Mandelbrot equation out of the realm of complex analysis can be offensive to some mathematicians. A gentler description is *sliding it off* the complex plane: when these genetic tweakers are set to default values, there is no change to the Set, but tweaking any one gene by the tiniest epsilon causes the Set to change its attitude ever so slightly. I ask the mathematician to think like a biologist for a moment. Studying messy nature shifts scrutiny to families of forms that are interrelated, imperfect, and always in a state of becoming.

The philosophical debate as to whether the Mandelbrot Set is completely human-made, or whether it is an eternal Platonic form, provides a backstory. Imagine if the Mandelbrot Set had come from a lineage of imperfect beings, whose genetic codes were wildly varied and continually evolving. Imagine now that the human mind, with its Platonic reach, had extracted perfection out of this menagerie, and revealed the Set as we now know it. My manipulation if the Set has allowed me to cast many shadows of the Set on the walls of Plato's cave. Some attributes seem to persist throughout this diverse family of forms. For instance, circular, spiraling, and curvilinear forms that are in the Set persist, though distorted, upon subversive tweakage, as Figure 3 shows.
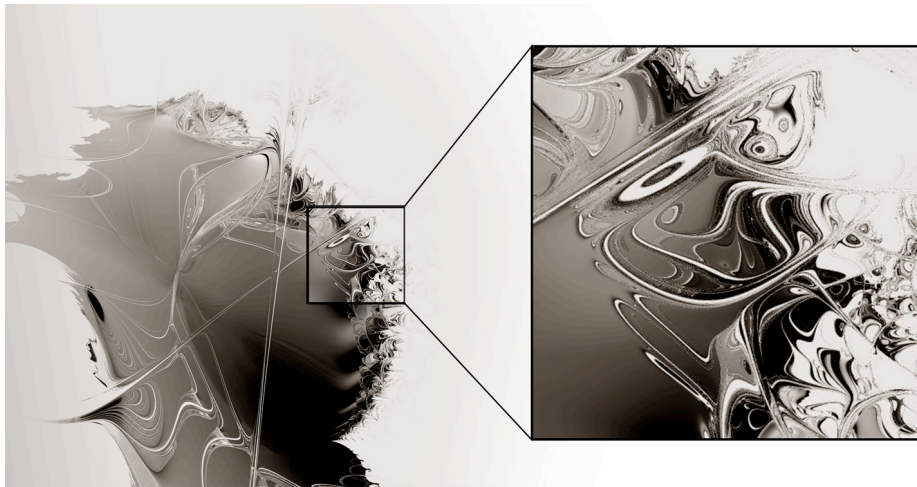
Fig. 3. Curvilinear forms exist in most tweaked variations of the Set.

Abstract expressionism; automatism; action painting – require giving up part of yourself to the raw energy that generates a painting. There is likewise a raw energy beneath the complex plane, having its own laws of nature, offering strange beasts. I have conjured many from the underworld. Like Pollack's drips, these curvilinear forms are determined by a dynamic process. But instead of the viscosity of paint and the gesture of a brush, it's the spin in the complex plane and the acceleration of that spin by recursion.

Fig. 4. A heavily-tweaked self portrait.

3 Portraiture

These are self-portraits. The genetic algorithm uses a digital image of my face as a fitness function. This process is described in detail in a paper I wrote for the book, *Design by Evolution* [2]. Instead of trying to design variables in the equation that can evolve so as to generate recognizable, realistic imitations, I allow the underlying dynamic to rear its ugly head, while the genetic algorithm attempts optimization towards a resemblance. In most cases, the only features common to the target image are the overall shape of my head and differences in shading. For me this is *just right*.

Fig. 5. Two examples of self-portraits based on the Mandelbrot equation

A painter working on a portrait might stop as soon as the essence of the subject has been captured, even as there are bare patches of canvas left, rough brush strokes, dribbles, and splotches. The physics of paint and canvas are allowed to have a voice in the final statement. These Mandelbrot-based images likewise permit the beasts lying beneath the complex plane to become a part of the expression. Since I have been exploring this family of beasts for more than twenty years, I have established kinship with them, and that is the main reason I consider them to be self-portraits.

References

1. Mandelbrot, B. The Fractal Geometry of Nature. Freeman, 1982.
2. Ventrella, J. Evolving the Mandelbrot Set to Imitate Figurative Art. Design by Evolution. Editors, Hingston, P., Barone, P., and Michalewicz, Z. Springer, 2008.