Fractal Patterns[1]

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Introduction

How can a *Mystery* as large as the universe find expression within the smallness of our souls? How can we tiny beings experience the *Infinite*? I found a new way to think about this question when I learned about fractal geometry.

A fractal is a pattern that repeats itself from an infinitely small scale to an infinitely large scale. The mathematician Benoit Mandelbrot first coined the word *fractal*, and brought to our attention the possibility of exploring the geometry of the natural world. Fractal comes from the word for broken, and Mandelbrot wanted to explore the rough shapes of nature. Traditional Euclidean geometry could not describe these shapes. Mandelbrot writes, "Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in straight lines."[2] Fractal geometry enables scientists to describe the world through complex mathematical formulas.

Perhaps you have heard of the most famous image associated with fractal geometry, which is called the Mandelbrot set. It has a dark area that looks a bit like the shape of a bug, with a large round spot, and a small attached round spot. But the edge is what makes it fascinating. It is filled with beautiful complex curlicues that continue to be complex curlicues no matter how much the image is magnified. In fact, it would continue through infinite magnification. The patterns continue no matter how small the image.

But "What is it?" I wondered. I am not a mathematician, but I was curious to see if I could make sense of the connection. If you have math anxieties, I promise you, I am only going to give a simple explanation with ten sentences. You are also welcome to zone out during the next paragraph.

A Mandelbrot set is a diagram of the mathematical equation, $Z = Z^2 + C$. You insert a number into the equation at Z, and the equation computes a new number at C. Then you start the equation all over again with the new number. But we don't care about the answer. We care about how many times you can repeat the process, with the number you started with. If you can repeat it only a limited amount of times, that number is part of the Mandelbrot set—and it becomes a black dot on your diagram, part of the black spot. If you can repeat it an infinite amount of times, that number is outside the Mandelbrot set. Depending on certain variations, it can be given a different color. Only computers can actually do all of these calculations, but they do them very well, and so we can see the beautiful images formed by the equation.[3]

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2 Benoit Mandelbrot, *The Fractal Geometry of Nature (Updated and augmented)* (New York: W.H. Freeman & Co.:1983, 1977), 1.

3 I didn't go into complex numbers or imaginary numbers, so my apologies to anyone who really knows about all of this. But for the rest of us, it is probably more than enough anyway. For those who want more detail, see

As I play this video for you, take note of how the patterns keep repeating themselves as the image is magnified.

Video Fractal Zoom Mandelbrot Corner[4] (YouTube)

Sermon

A fractal is a pattern that repeats itself at all levels of scale. Why should fractal geometry matter to those of us who are not mathematicians? First of all, it gives human beings a new way to look at the universe. When we can describe something, we can see it better than if we cannot describe it. Because we are better able to see the natural world, fractals enable us to have a deeper relationship to the natural world.

It is similar to learning to read. In order to read, we need to understand the patterns of squiggly lines that form the letters of the alphabet. And then we need to understand how those squiggly lines are combined in multiple ways to form words, and then sentences, and so on. A person who cannot read may look at a book, and it might seem beautiful, or there might be pictures in it to be curious about, but that person cannot understand what it means. When we learn to read the patterns of squiggly lines, the book becomes a doorway into a whole story, and suddenly we have access to a wealth of ideas and emotions and understandings.

The natural world is like a sacred text; it is the place where we search for truth and beauty and goodness. We don't have to understand the world to appreciate its beauty. Even a baby can laugh with delight at the bright colors of flowers, or try to catch a butterfly. But the more we understand the natural world, the deeper our appreciation can be, and the more its mysteries open up to us. Fractals can increase our capacity to read the book of the universe.

Once mathematicians were able to measure and describe the complex patterns in the natural world, they realized that patterns permeate the universe. A fractal is a pattern that repeats itself, from an infinitely small scale to an infinitely large scale. In nature, the patterns and shapes may not be infinite, but there is self-similarity at all levels of scale. A classic example is the fern plant. The pattern in the stem and branches of the fern repeat in the patterns of each branching segment, and of the leaves themselves. Complex entities are created from simple designs extended out to many dimensions.

This has both practical and mystical applications. I learned about one practical application from a documentary called *Hunting the Hidden Dimension*.[5] A group of scientists concerned about global warming was trying to determine how much carbon dioxide was absorbed by trees in the rain forest. They could measure the carbon capture of a single leaf, but how could they count the number of leaves in the forest?

Introduction to the Mandelbrot Set: A guide for people with little math experience by David Dewey, at: http://ddewey.net/mandelbrot/.

4 The Fractal Zoom Mandelbrot Corner by Gaurav Vohra can be found at YouTube at http://www.youtube.com/watch?v=G_GBwuYuOOs

5 *Hunting the Hidden Dimension*, Produced and Directed by Michael Schwarz and Bill Jersey, © 2008 WGBH Educational Foundation and The Catticus CorporationFor more information: http://www.pbs.org/wgbh/nova/fractals.

They had an idea. They started by measuring the circumference of all of the branches on a single tree. Because of the fractal nature of the tree, the branches form a regular pattern, dividing at certain intervals into smaller and smaller branches. By measuring every branch, they could determine the ratio between branch sizes. Then they took it one step further. They measured the trunks of all of the trees within a given area.

Imagine it with me. If we walk through a forest we see trees of all sizes—small saplings, huge old giants—there is an endless variety of sizes all around us, seemingly in a random pattern. But it turns out it is not so random. The ratio of tree sizes in an area of natural forest is approximately the same as the ratio of branch sizes on a single tree. There is a pattern to it. And by learning the patterns, the scientists could compute how many leaves were in the forest, and how much carbon dioxide they would absorb.

Now when I walk through the forest near my new home, I remember this experiment, and wonder if these trees, too, have patterns related to their size and company. What always seemed chaotic and random might be full of a kind of symmetry that could reveal itself to me, if I gaze with deeper insight. My experience of the trees' beauty expands, and I feel a growing sense of awe. I find myself looking for fractal patterns everywhere. This new understanding has changed the way I see the world. And it is not only visual. I can feel the patterns in bark with my fingertips, and I start to listen for patterns in the sounds I hear as well. Next time you look at a spider's web, or gaze into the clouds in the sky, watch for the fractal patterns.

Our ability to measure the patterns in the natural world has also given us the ability to create digital worlds that remind us of our own. Fractal formulas are used to generate computer graphics that look realistically like mountain ranges and rivers and forests and clouds. That wasn't possible a few decades ago. Such formulas have been used to design antennas in greatly reduced sizes, which enabled the creation of the next generation of cell phones and other electronic communicators. Fractal geometry is enlarging our ability to create new devices that work better, because they follow patterns that resonate with the natural patterns around us.

But what about the mystical application of fractals? It has to do with a very old spiritual quandary. How can we tiny human beings communicate with an infinite *Divine Being*? How can a *Mystery* as large as the universe have any connection with our limited human experience? I know I have had moments in my life when I felt connected, when I even felt cared for by a *Mystery* greater than myself. But if *God* is infinite, or if the *Mystery* is all that is, how can that be? How can a *Mystery* as large as the universe connect to a being like me, so small as to be almost invisible on the planet?

Fractals have given me a new way to think about this dilemma. We have learned a fractal is a pattern that endlessly repeats itself, from an infinitely large scale to an infinitely small scale. What if *God* is a fractal? What if *God* is a pattern that repeats itself from the infinitely large to the infinitely small?

Here is how I imagine it. The *Divine* pattern is a pattern of life and connection and creativity—it expresses itself in the creative unfolding of the universe. It repeats in the attractions of planets and stars, and in the evolution of life itself. Because fractals continue to repeat in self-similar ways at all scales of size, the same *Divine* pattern emerges at the size of our own human consciousness. We can find that pattern in our hearts, in our personal experience of life and love and creativity. Thus we can find the *Mystery* in our hearts, as well as in the larger whole.

By understanding fractals, my intellect can make sense of what my heart experiences of the *Divine*. It helps me to make sense of the tender feelings I feel, and to welcome this help for the troubles life brings. I feel less lonely, when I feel connected to the *Divine* love. It becomes possible to believe I matter, that I am not just a speck of dust in a vast uncaring universe. I have within me the fractal beauty of the infinite *Mystery*.

Human beings have always used images to help us understand the mysterious. Many images of *God* are like bigger versions of human beings: a father, a king, a ruler, a judge, or a lord. But when our understanding of the universe grows more complex than these images, or we are hurt by these images, people are tempted to give up on the idea of *God*. For many people, it doesn't make any literal sense to imagine a huge king up in the sky somewhere. And if our experience of these authority figures has been difficult, their images are more likely to inspire fear and guilt rather than help us live our lives.

To imagine *God* as a fractal pattern, a pattern of life and love and creativity, helps me to be a whole person—to bring together my reasoning and my heart and my spirit. Of course, it is not a new thing to compare *God* to a geometric shape. The Christian tradition has used the triangle to describe *God* as trinity. But while the triangle is a static, simple, and smooth figure, a fractal has multiple dimensions, and infinitely complex variations and expressions. That fits my understanding of spirituality—I believe there are infinite variations in the ways we can experience the holy. As the Sufi poet Rumi says, "There are hundreds of ways to kneel and kiss the ground."[6]

Anthem Celebration Nancy Telfer

Conclusion

There is a third reason why fractals matter. They teach us *we* matter. Fractal patterns are another way we can see that all things are connected. The circulatory system of the human body branches out like the limbs on a tree. The patterns of waves on the shoreline are similar to the patterns of radio waves beaming through space. Even though we are infinitely small in comparison with the rest of the universe, what happens on a small scale reflects what is happening on a larger scale.

6 *Coleman Barks with John Moyne, trans., The Essential Rumi* (Harper San Francisco, 1995), 36.

Some of these patterns may seem to be unchanging and eternal, but there is also unpredictability in the system. Scientists use the word *chaos* to describe this unpredictable behavior. Without chaos, there could be no creativity, because creativity means the emergence of something new and unpredicted.

Perhaps you may have heard of the "butterfly effect." This phrase was used by Edward Lorenz to describe the impossibility of predicting the weather, despite creating complex computer models that looked at multiple variables. Lorenz found that a small change in the initial conditions would produce large changes when the patterned cycles repeated many times. It was expressed in metaphor as the butterfly effect: a butterfly flapping its wings in South America can change the weather in Maine.

We have creative power as human beings. That means what we do within our patterns has an effect on the rest of the fractal network. We are part of an interdependent web of all that exists. If we change a pattern in our lives, it reverberates through the rest of the web; it ripples out like a stone thrown into a pond. We never really know what greater effect we will have on the future of the universe. We cannot control the ripples that flow out. But we do know we have the power to create more beauty, more love, more truth, and more goodness in the web. What we do matters.

Meditation

Closing Words
Let us close our reflections with the words of Rumi:
Let the beauty we love be what we do:
there are hundreds of ways to kneel and kiss the ground.