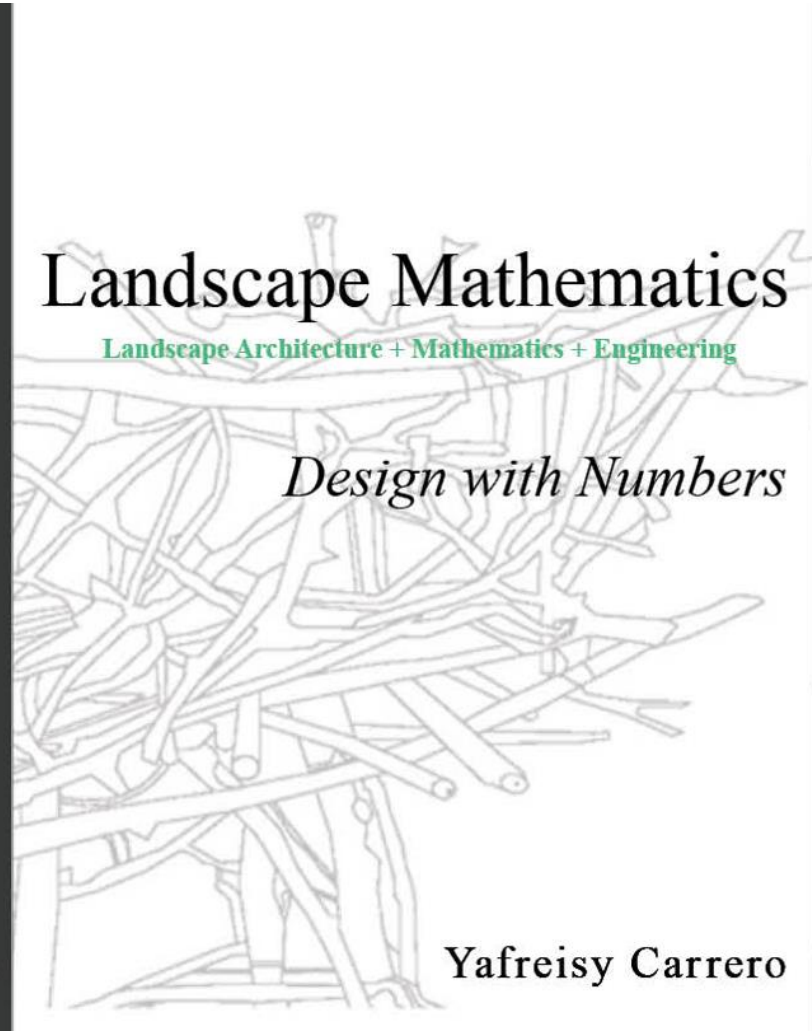
About the Author

Yafreisy Carrero is the first Landscape Mathematician, who creates original landscape architectural systems using the beauty and logic of numbers. One of her passions is introducing people to her *mundo de números*. She is a Dominican-born American raised in the Bronx in New York City since age four. Multilingual in English, Spanish, Portuguese, she considers Mathematics to be her first language.

Yafreisy is the Founder + Creator of Landscape Mathematics: a STEM field that combines knowledge of landscape architecture, mathematics, and engineering used to design, build, and perceive this world of numbers. She is also the Founder + Creator of LandscapeMathematics.Global, which informs about the beauty and logic of mathematics in nature. This website is the platform for the Landscape Mathematics STEM field that she created and founded in 2015.

Yafreisy holds a B.A. in Mathematics, and Minor in Fine Arts from the College of Mount Saint Vincent in New York City. Her background is also in Architecture and Landscape Architecture, and she has an M.S. in Civil, Environmental, and Water Resources Engineering from George Mason University. Yafreisy takes on all challenges, providing solutions to both environmental and educational issues worldwide.



MATHEMATICAL NATURE

Imagine a world composed of mathematically designed solutions. A world of numbers structurally expressed not only on buildings but in the landscape, and all over the globe. A world, where people can recognize and understand the seen and unseen logic of mathematics in nature. A world of theory, philosophy, beauty, and logic that functions naturally and systematically as a whole. This is my world of numbers! A world created and designed with numbers. A hidden world—that is yet to be uncovered by all.

Nature already uses the language of mathematics, so why not work with the environment instead of against it. We need to start mimicking the mathematical logic that occurs in the landscape, identify existing systems, and out of those concepts create new ones.

Mathematical design is the future. Landscape Mathematics is the revolution!

Let's explore our world of numbers!

Preface

Through the eyes of the first Landscape Mathematician

Landscape Mathematics = Landscape Architecture + Mathematics + Engineering™. Complex mathematical systems exist in nature. We must mimic these systems, and create original ones, to solve environmental and educational issues worldwide.

Imagine a world composed of mathematically designed solutions. A world of numbers structurally expressed not only on buildings but in the landscape, and all over the globe. A world, where people can recognize and understand the seen and unseen logic of mathematics in nature. A world of theory, philosophy, beauty, and logic that functions naturally and systematically as a whole. This is my world of numbers! A world created and designed with numbers. A hidden world—that is yet to be uncovered by all.

I am Yafreisy Carrero, the first Landscape Mathematician, who creates original Landscape Mathematics systems using the beauty and logic of numbers. I am Multilingual in English, Spanish, Portuguese, and consider Mathematics to be my first language.

I see the world in a unique way, mathematically, as a Landscape Mathematician. I see a world of numbers. When I observe nature, concepts and visualizations form in my brain, and systems start to connect mathematically.

In the past, I was constantly proving my knowledge of this world of numbers to people who did not understand and were not interested in making the connection between mathematics and design in nature.

When the reality is, we design with numbers subconsciously. We use mathematical systems to teach, learn, and function every day. It is natural for us to use numbers.

The younger generation must understand that

they are learning and communicating with numbers, or the effects of thinking otherwise will continue onto adulthood.

I know my thinking is revolutionary and worth spreading!

Recognizing the truths of mathematics in landscape architecture, engineering, and other STEM fields—helped me understand that we need to change design and education, people are not learning to love or think of mathematics as our first language.

The truth is, many people are afraid of mathematics. We must remember that our knowledge and understanding of numbers exist within us.

Mathematics is already our first language.

We are a product of love, beauty, and logic, and we communicate using numbers. When we help each other, we evolve. We are connected and created mathematically.

Mathematics solves the unimaginable problems of

the world.

When our living environment does not provide the necessary resources to survive, we create solutions with nature. We mimic nature by following its laws of mathematics.

We mimic nature, and nature mimics us.

Mathematics is the language of nature.

Nature already uses the language of mathematics, so why not work with the environment instead of against it. We need to start mimicking the mathematical logic that occurs in the landscape, identify existing systems, and out of those concepts create new ones.

Being able to solve the logic of mathematics in nature, strengthened my passion for numbers to another level. Math was no longer my best friend, but *mi fuerza*. I want others to understand and recognize what they see in nature, and that mathematics is a valuable language worldwide.

I am the Founder and Creator of Landscape Mathematics, an interdisciplinary STEM field that combines knowledge in landscape architecture, mathematics, and engineering used to design, build, and perceive this world of numbers.

My field is the foundation for innovative thinking and global evolution!

I use my knowledge and expertise in Landscape Mathematics to educate others with the beauty and logic of numbers and design the world, as the first Landscape Mathematician in this world of numbers.

We must reconstruct our relationship with mathematics to increase our confidence in numbers and understanding of the world.

We need a world where everyone can express their love for mathematics and live without fear of numbers. A world that mimics nature and creates original systems and advances with beauty and logic. This Landscape Mathematics offers.

For some time, I was a negative number searching for a positive destiny.

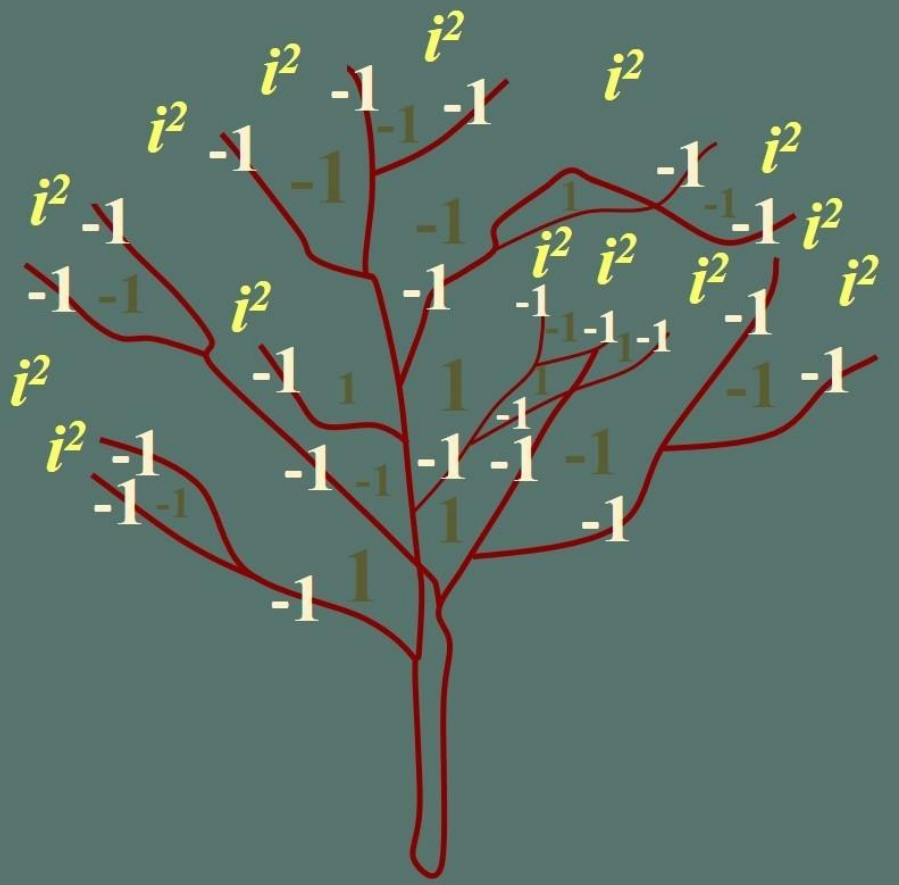
Silence is not fear. The absolute truth is powerful, and it reveals itself all on its own. It never stays hidden. It unveils when you need it the most. Patience is the key. I have been to hell, and I came back stronger and fearless for *mi mundo de números.*

Everyone should feel welcome in this world of numbers. I found my passion in life. I found a world where I can create and design with numbers! I want everyone to find their own mundo de números!

Let's discover our world of numbers!

The world is Landscape Mathematics!

Decoding and Mimicking Nature: Yafreisy's Fractals



This is the age of Landscape Mathematicians!

The rise of the Landscape Mathematics STEM Field!

This is the Mathematical Revolution of Beauty and Logic of this World of Numbers!

¡Esta es la Revolución Matemática de la Belleza y la Lógica de este Mundo de Números!

The World is Landscape Mathematics!

Mathematics became another language that I understood better than English *since I was four years old*. It made me realize my passion for mathematics because of the beauty it expressed with its geometric figures. The overlapping of the figures and its symmetry created a three-dimensional world. The laws of mathematics created a hidden place for me, my best friend. When it came to mathematics, nothing stopped me from being in *mi mundo de números*.


Fractals, 2016. © Yafreisy Carrero. All rights reserved.

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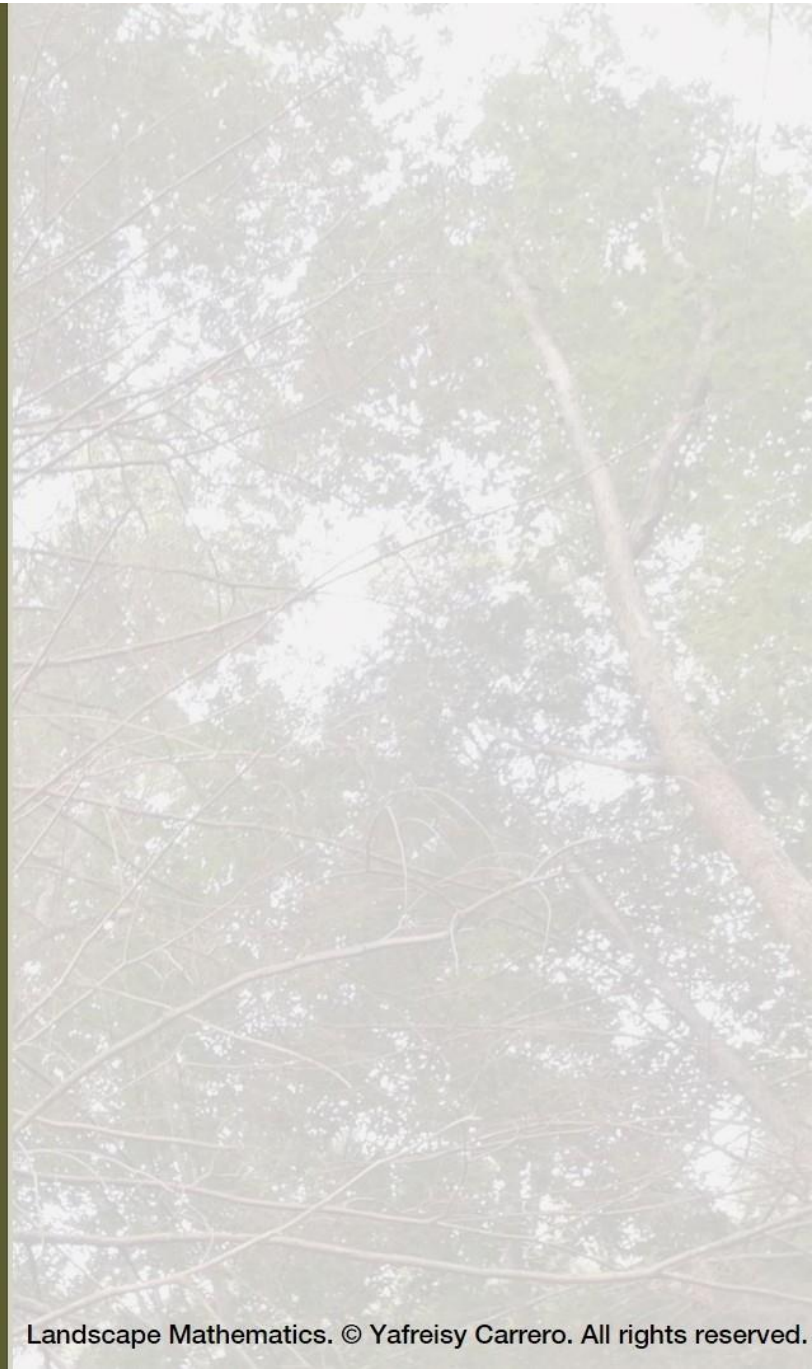
I see the world in a unique way, mathematically, as a Landscape Mathematician. I see a world of numbers! When I observe nature, concepts and visualizations form in my brain, and systems start to connect mathematically.

Landscape Mathematicians design and create this world of numbers.

Carrero's 3rd Law of Landscape Mathematics

The moment you start to recognize and understand that mathematics is the language of nature, and *see* the *unseen* laws of this beautiful world of numbers, and mimic its logic to create original systems, you are a Landscape Mathematician.



Landscape Mathematicians, *Matemáticos Paisajistas*, are mathematical thinkers, designers, philosophers, scientists, and inventors, and can easily recognize and understand the beauty and logic of this world of numbers.

Landscape Mathematicians

Landscape Mathematicians, *Matemáticos Paisajistas*, are mathematical thinkers, designers, philosophers, scientists, and inventors, and can easily recognize and understand the beauty and logic of this world of numbers.

Mathematics is our first language! By translating the systems we see in colors, shapes, and numbers, we reveal the logic of this beautiful world.

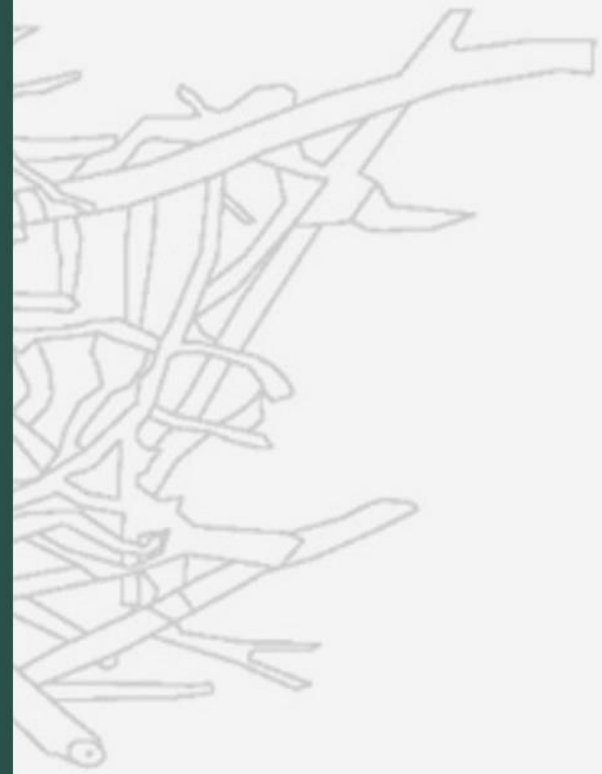
Landscape Mathematicians see a world of numerical solutions.

We see a world of Landscape Mathematics: 1) fractals on trees, 2) matrix network systems in favela communities—my inspiration for creating and building, the Carrero 3x3™ Roof mathematical water filtration system that grows food of the first Landscape Mathematics global Project, Roof-Wall-Landscape Matrix Network™, 3) the orthogonal projections expressed on the historical landscapes of Washington, D.C. and all over the world, and 4) the principles of astronomy and Euclidean geometry created in the design of the Pioneer Courthouse Square in Portland, Oregon, and globally. These are a few of the magnificent examples of this world of numbers ***(see Chapter 2).***

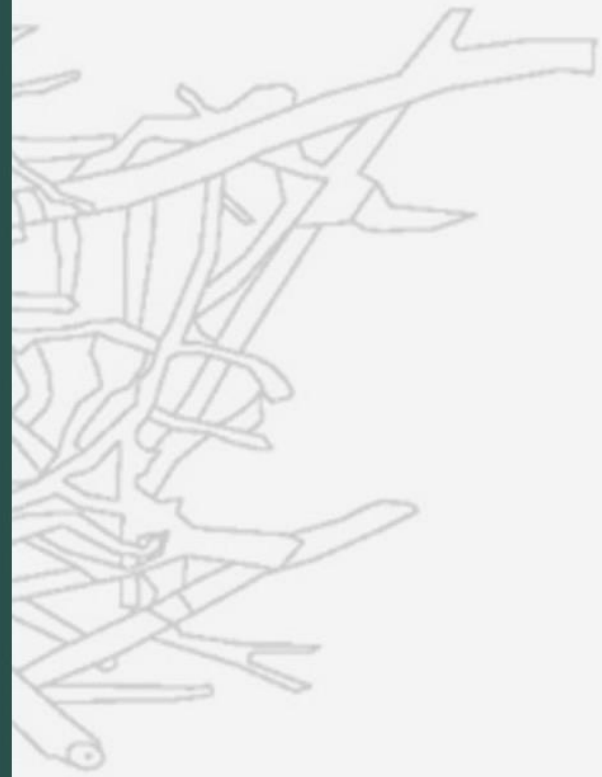
Landscape Mathematicians are the bridge of knowledge between humans and nature.

Nature communicates using the language of mathematics. ***When we decode nature's logic, we create original algorithms, designing systems with its laws of numbers.***

Landscape Mathematicians possess the understanding that drives the seen and unseen beauty and logic of this world of numbers.



Landscape Mathematicians understand how the world functions. We design and create laws with numbers, maintain the peace between humans and nature, and create innovative solutions with our futuristic originality.



We translate and mimic nature's beauty and logic.

Roof Prototype of the Carrero 3x3™, Roof-Wall-Landscape Matrix Network™, Landscape Mathematics Global Project

My first Landscape Mathematics global Project: Roof-Wall-Landscape Matrix Network™ is the combination of landscape architecture, mathematics, and engineering. My Project is a unique, complex design consisting of a sequence of Roof-Wall-Landscape Systems' within a larger Roof-Wall-Landscape Matrix Network™ that mimics mathematical landscapes. I recognized the concept of matrices in group theory in the favela landscapes of Brazil. When applying sequences of my Roof-Wall-Landscape System™ to each favela home, it creates a matrix neural network that improves green infrastructure, stormwater management, water quality, and reduces flood hazards for the community as a whole and the world.

One of its components is Carrero 3x3™, the Roof based mathematical natural water filtration system that gives access to potable water, maximizes food production, collects water, and reduces stormwater runoff. It creates a self-sustaining cycle, using concepts found in mathematics, physics, geography, biology, landscape architecture, and engineering.

Landscape Mathematicians see a world of Landscape Mathematics.

Ants, bees, and butterflies are Landscape Mathematicians.

The logic of this beautiful world of numbers surround us. This world is Landscape Mathematics!

Landscape Mathematics™

Landscape Architecture + Mathematics + Engineering

Landscape Mathematics is an interdisciplinary STEM field that combines knowledge in landscape architecture, mathematics, and engineering used to design, build, and perceive this world of numbers.

Landscape Mathematics teaches how to recognize and understand the seen and unseen beauty and logic of this amazing world.

Carrero's 1st Law of Landscape Mathematics

Mathematics is the language of nature. If you understand nature, you understand mathematics.

Our brain functions using fractal geometry; the dendrites of neurons resemble the branches of trees; our thinking mechanism and actions form fractal systems; clouds express fractal patterns, and lightning sparks and leave its fractal fingerprints on the landscape. The mathematical logic of this beautiful world of numbers surrounds us. Fractals are everywhere. Symmetry is everywhere.

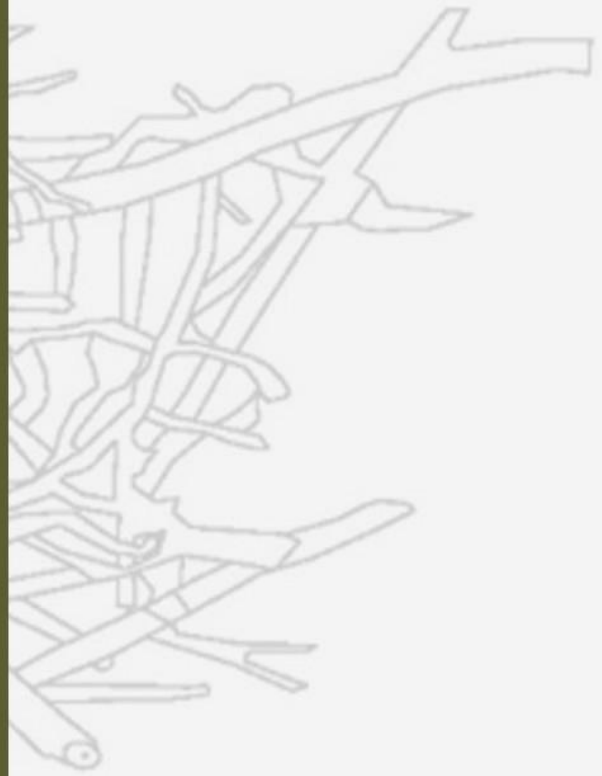
When I see trees, I see fractals!


Fractals, 2015. © Yafreisy Carrero. All rights reserved.

Humans perceive the symmetry of patterns all over the world. ***When I see trees, I see fractals!***

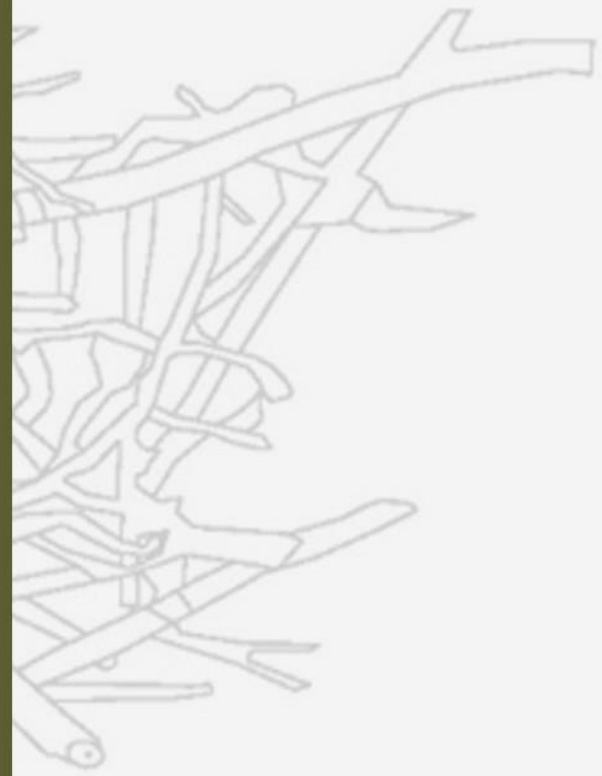
Fractals are patterns of chaos, but they have order and a central point to their creation.

They are magnification symmetry. Fractals express beautiful and logical sequences of self-similarity at different scales forming groups.



Trees are natural fractals starting from their roots to their branches, satisfying group axioms to survive.

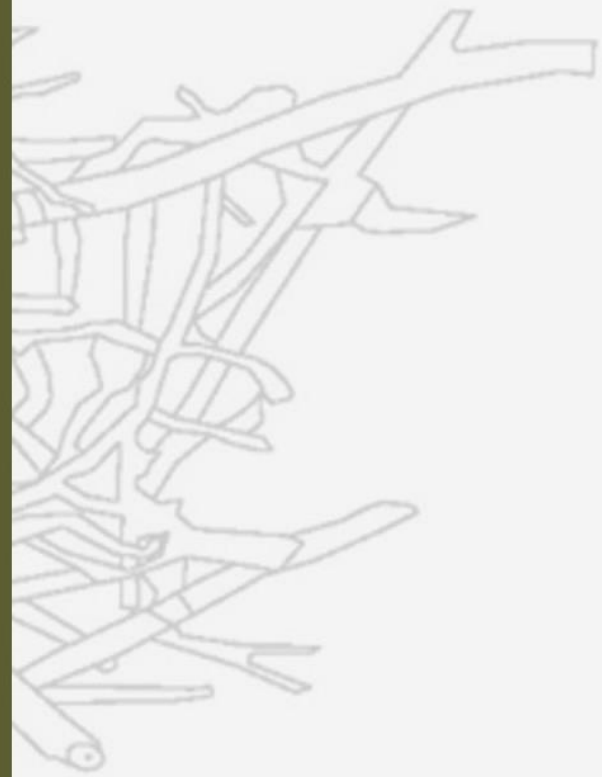
The Landscape Mathematics design of a tree contains four principal parts: 1) the roots, 2) the trunk, 3) the branches, and 4) its leaves. The crown is where the branches and leaves grow. Each part is a group expressing and using their fractal system, creating the complexity of the tree's existence.



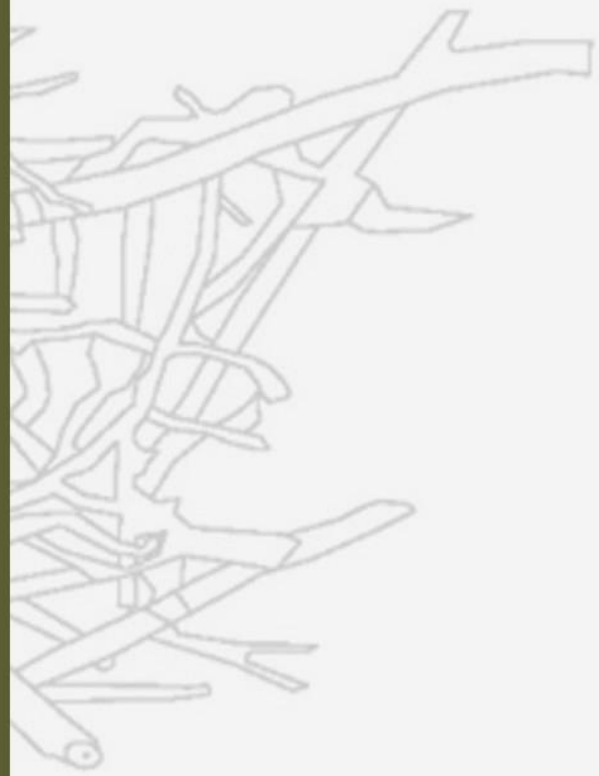
The Complex Fractal Design System of Trees

The *roots* absorb water and nutrients from the soil; the *trunk* is the connector and the foundation for the structure of the tree; the *leaves* make sugar from the water and air, and it is the *branches* that help the leaves receive its sunlight for photosynthesis.

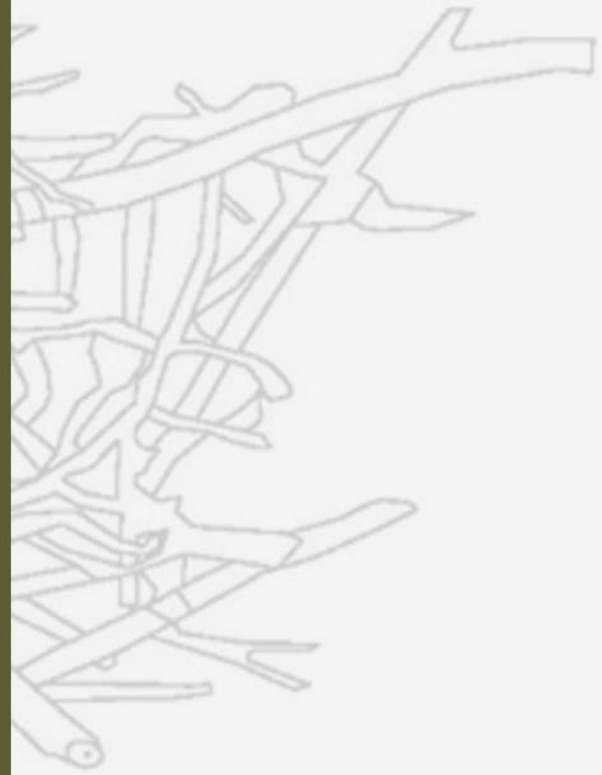
The tree's branching pattern is the key!



The tree's groups express their fractal systems separately; however, they mimic each other, and they are connected. The crown is the result of the logic of their complex design, where the branches the main elements of the tree grow systematically, creating and designing natural mathematical solutions with their number, size, and position, satisfying group axioms for photosynthesis.



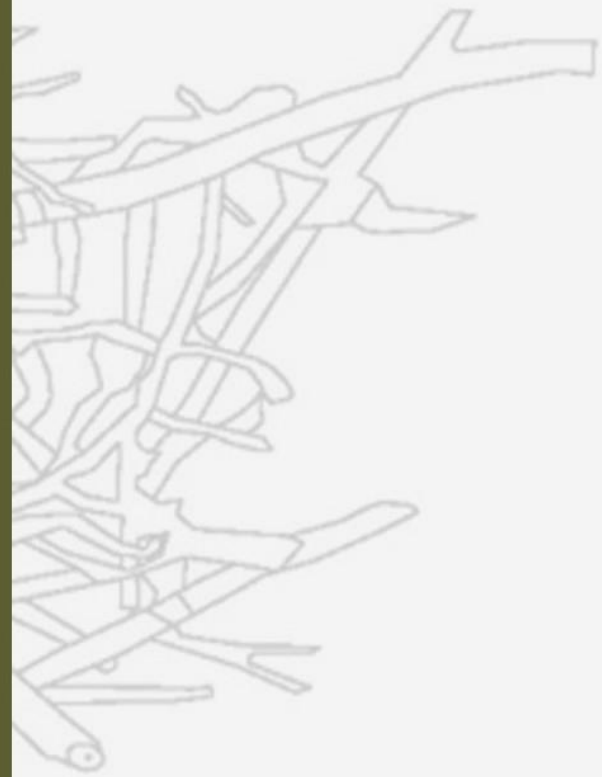
The large branches start at the trunk, and they are the sub-foundation for the sequential scaling of the medium branches in the tree. Then, the medium branches provide the mid-foundation for the fractal system of the smaller branches, until it reaches infinity, and never touches the sky. Each stage of the branches mimics its previous existing system, just like the complex fractal design system of the entire tree.



Trees are beautiful fractals of nature, producing different branching patterns that are dependent on their species, age, and their environment for survival.

The complexity of a tree's fractal system advances when they compete with other trees and communicate mathematically.

Behind all that chaos, there is beauty and logic in their growth.



What I find fascinating about fractal patterns in trees is the system of its branches, and how their multiplication creates fractal spaces.

In trees, when the branches multiply, they create spaces seen as shapes.

The number of branches completing the shapes determines if the spaces are positive or negative.

The sequence of the spaces creates a fractal pattern, mimicking the existing fractal system of its branches.

The relationship between the branches and the size, shape, and value of their spaces is part of the tree's survival strategy.

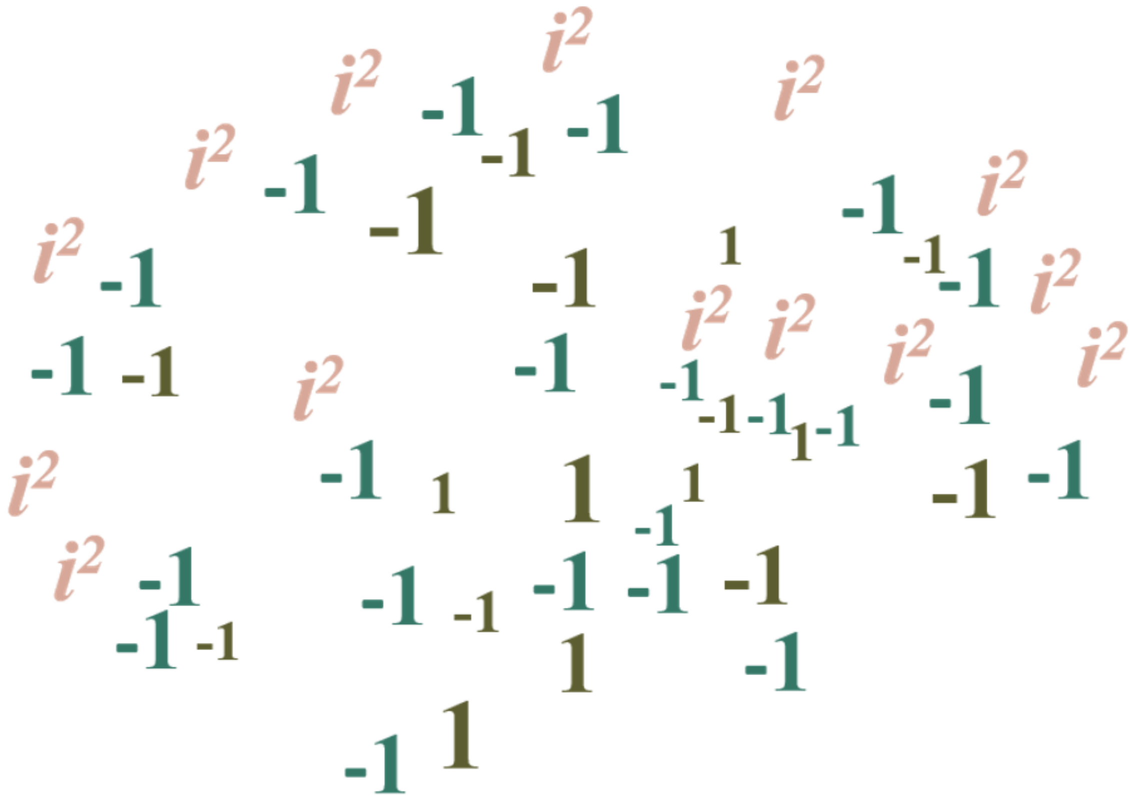
The branches are central for the tree to receive the most sunlight for photosynthesis.

Everyone sees trees differently. This is the beauty of our connection with nature, and how we each solve its logic!

The branches multiply, and their spaces become shapes.

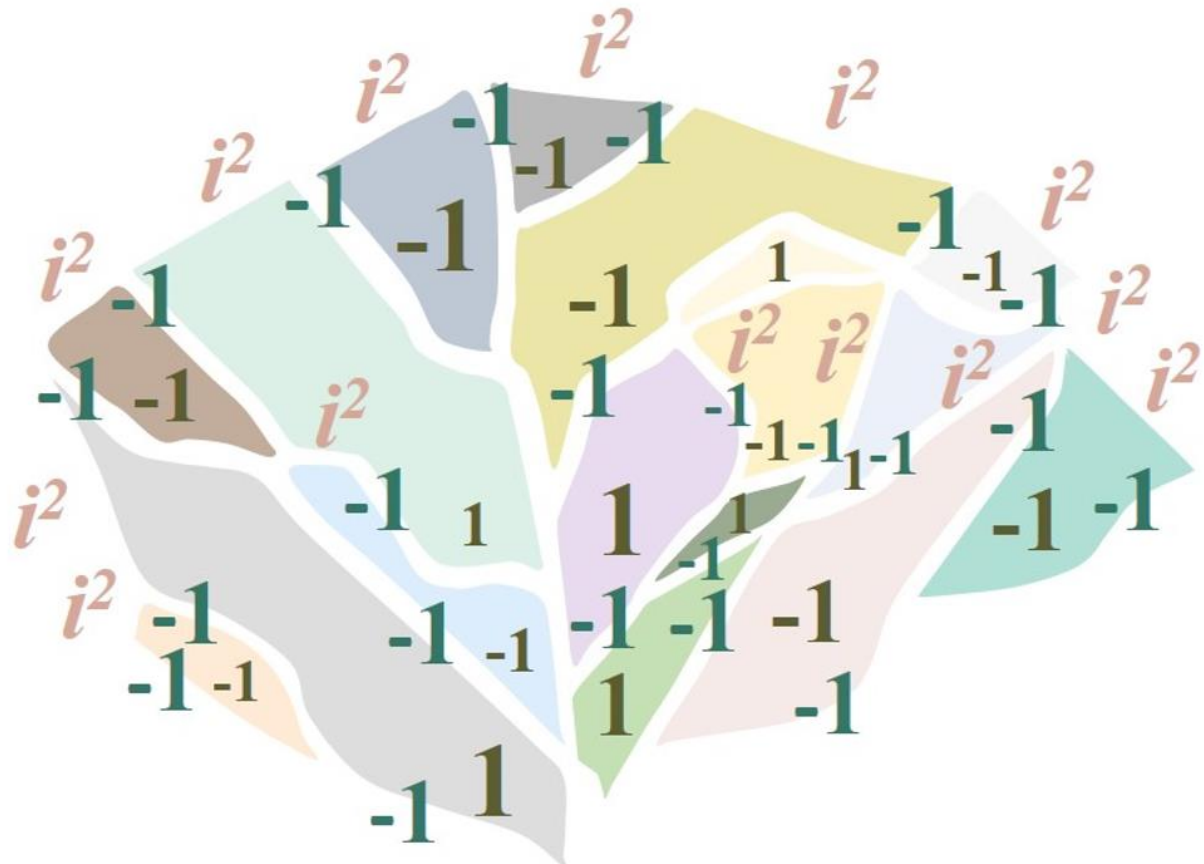
I see numbers; I see shapes.
I see the beauty and logic of
trees. I see Yafreisy's Fractals!

I see numbers;

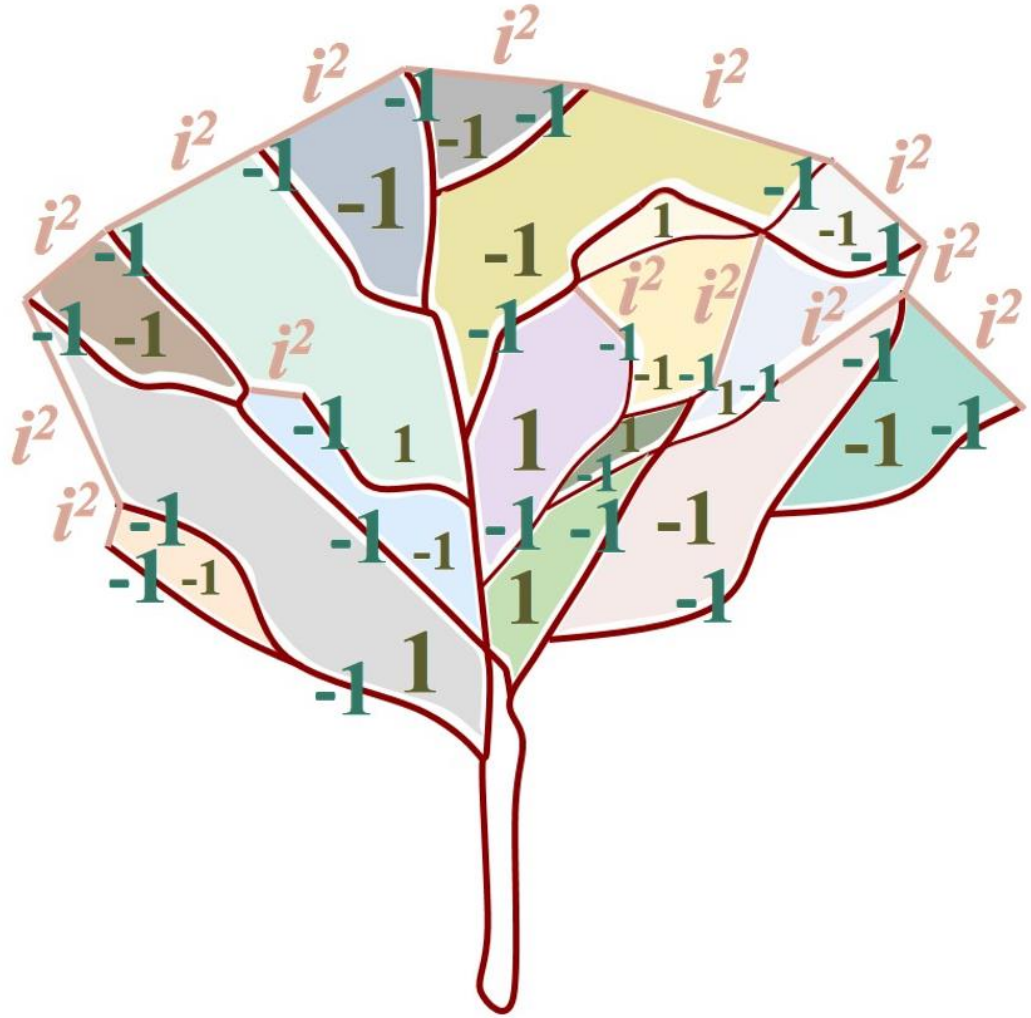


I see shapes;

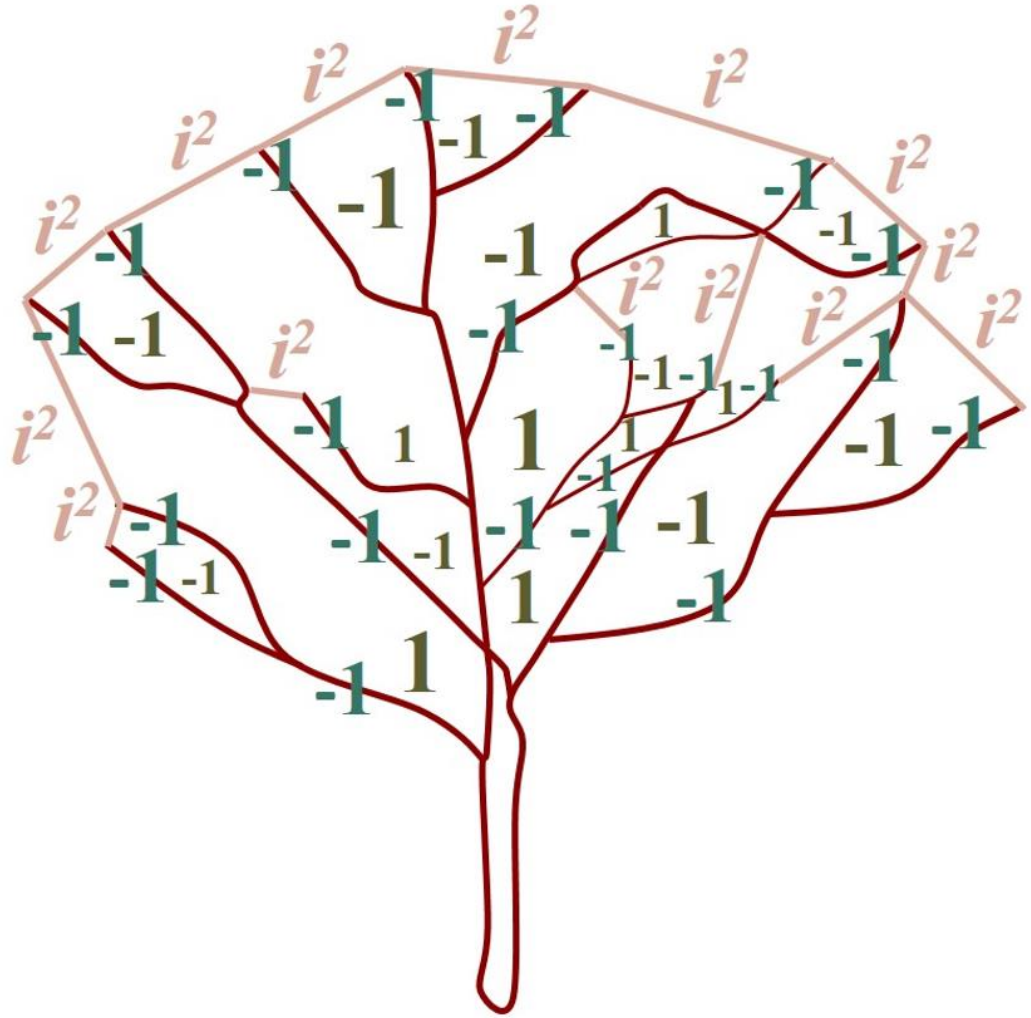
I see numbers and shapes;



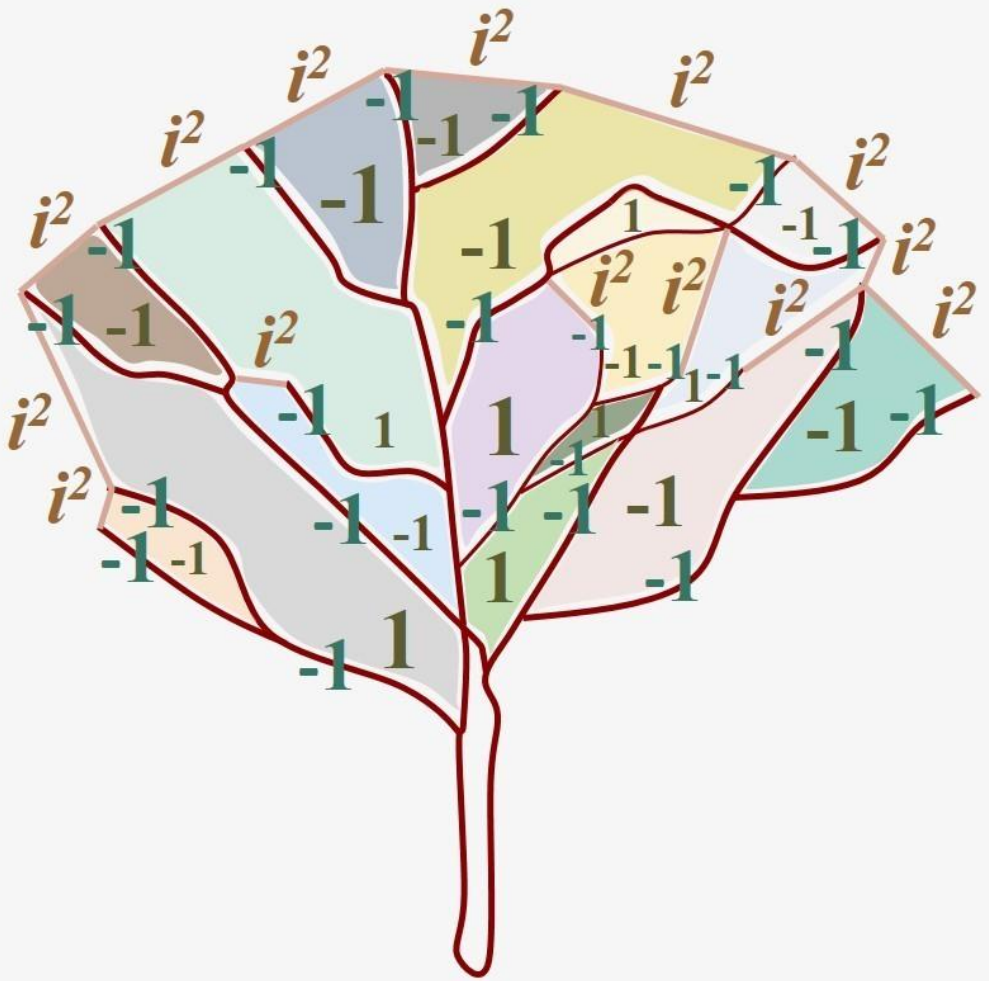
I see Yafreisy's Fractals;



The beauty and logic of trees!

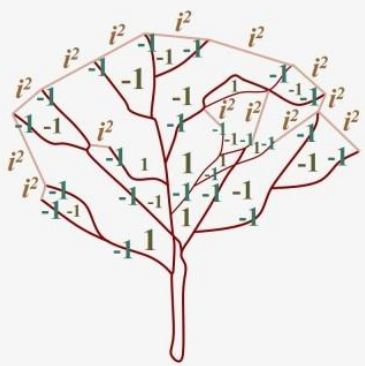


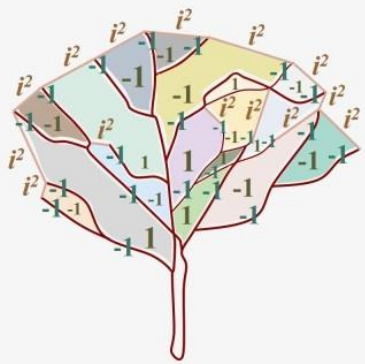
Yafreisy Fractals



-1 Real Branches i^2 Imaginary Branches 1 or -1 Spaces

Yafreisy Set Algorithm





The real branches, the imaginary branches, the shape of their spaces, and their numerical values are all elements in trees' crown fractal systems.

The real branches are -1, the imaginary branches are $i^2 = -1$, and their spaces are 1 or -1 .

The shapes and values of the spaces are dependent on the number, size, and position of the branches.

Yafreisy Axioms

1. *Two or more branches give a space its shape.*
2. *A shape is a close complete space.*
3. *When branches do not intersect, the shape is completed by an imaginary branch, called* $\mathfrak{b}_i$ *which is equal to -1.*
4. *Intersecting branches that close a space do not use an imaginary branch,* $\mathfrak{b}_i = i^2 = -1$ *because the shape is complete.*
5. *An extending branch can be shared with other branches to complete other shapes, even if the branch is imaginary.*

An odd number of branches create negative spaces, and an even number of branches produce positive spaces.

Yafreisy Set Formula

The Yafreisy Set Formula calculates the value of the spaces created by the multiplication of the branches, which consist of the number of the real and imaginary branches that form the shapes; the formula determines if they are positive or negative.

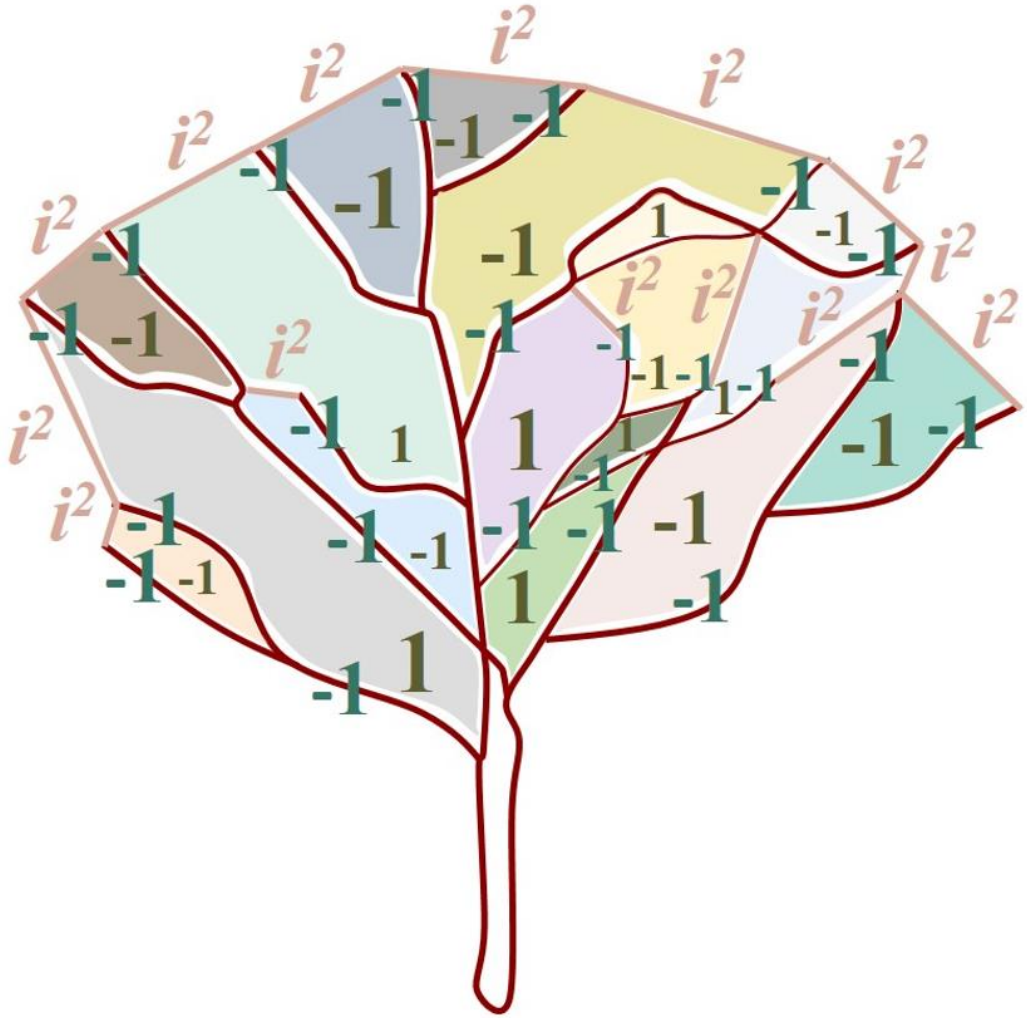
Yafreisy Set Formula variables: n = number of real branches, b = value of real branches, b_i = value of imaginary branches, $b_i = i^2 = -1$, n_i = number of imaginary branches, and y = value of space.

Yafreisy Set Formula

$$y = b^{n} \times (b_{i})^{n_{i}}$$

b = -1 = value of real branches.
n = number of real branches.
$b_i = i^2 = -1$ = value of imaginary branches.
n_i = number of imaginary branches.
y = value of space.

Yafreisy Fractals, using the Yafreisy Set Formula!



A : = $n = 2, b = -1 , b_i = -1 , n_i = 0, y = ?$

$y = (-1)^2 \times (-1)^0$

$y = 1 \times 1$

$y = 1$

B : = $n = 2, b = -1 , b_i = -1 , n_i = 1, y = ?$

$y = (-1)^2 \times (-1)^1$

$y = 1 \times -1$

$y = -1$

C : = $n = 3, b = -1, b_i = -1, n_i = 0, y = ?$

$y = (-1)^3 \times (-1)^0$

$y = -1 \times 1$

$y = -1$

D : = $n = 4, b = -1, b_i = -1, n_i = 0, y = ?$

$y = (-1)^4 \times (-1)^0$

$y = 1 \times 1$

$y = 1$

E : = $n = 5, b = -1, b_i = -1, n_i = 0, y = ?$

$y = (-1)^5 \times (-1)^0$

$y = -1 \times 1$

$y = -1$

Yafreisy Set Algorithm

The Yafreisy Set Algorithm reveals the sequence of fractal groups known as Yafreisy Fractals, mimicking each other's systems in trees.

The algorithm translates the connection between the fractal groups of the real branches, imaginary branches, their spaces, and the logic of their numerical values.

The branches create a fractal system, the shape of the spaces mimics this logic, and the sequence of their numerical values creates a fractal pattern, which is the complex product of Yafreisy Fractals, satisfying Yafreisy Axioms, and the values generated by the Yafreisy Set Formula.

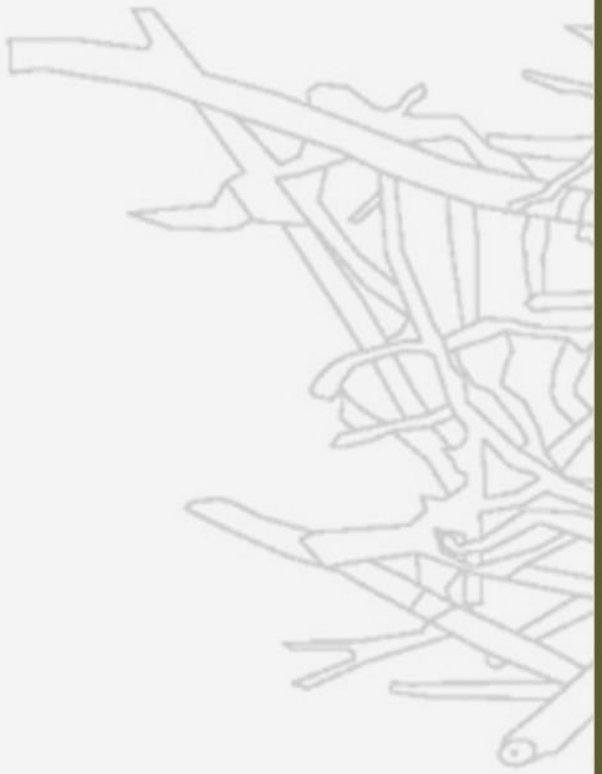
The numeric product of the spaces indicates if the tree's crown fractal system is positive or negative.

The results will help humans monitor trees, so they can continue to exist in healthy mathematical environments.

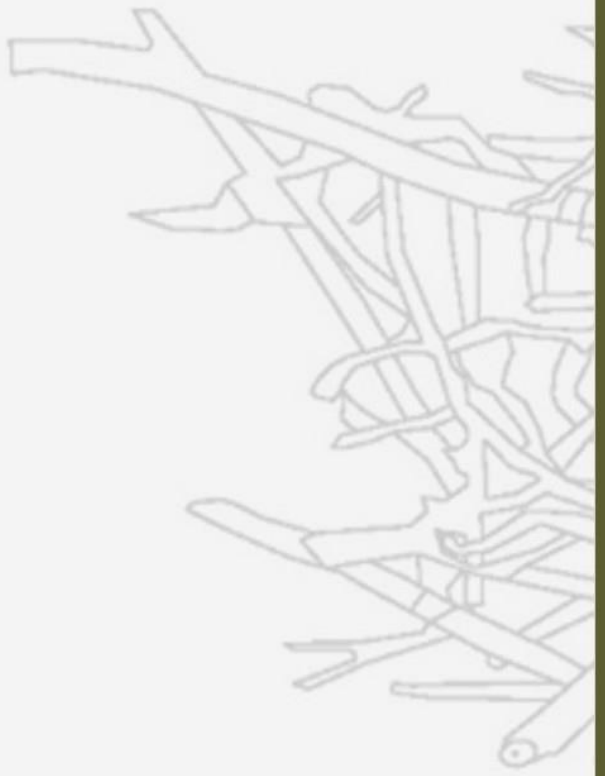
Nature communicates using the language of mathematics.

Carrero's 2nd Law of Landscape Mathematics

Nature already uses the language of mathematics, so why not work with the environment instead of against it. We need to start mimicking the mathematical logic that occurs in the landscape, identify existing systems, and out of those concepts create new ones.



Lo recuerdo como si fuera ayer...

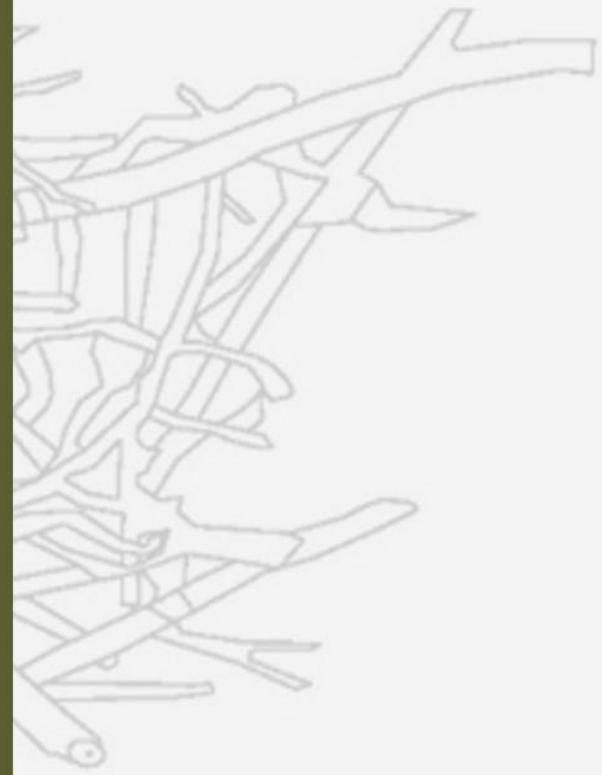


Era un bellísimo día soleado y me senté debajo de un árbol para admirar el paisaje del Bronx en la ciudad de Nueva York. Estaba en mi mundo de números, rodeada por la belleza y la lógica de la naturaleza.

Inmediatamente observé las ramas de los árboles desconectadas en la hierba. Estas ramas eran elementos faltantes de un sistema fractal existente. Vi un diseño original en ellas, con una forma y función diferente, expresando una nueva belleza y lógica de los números.

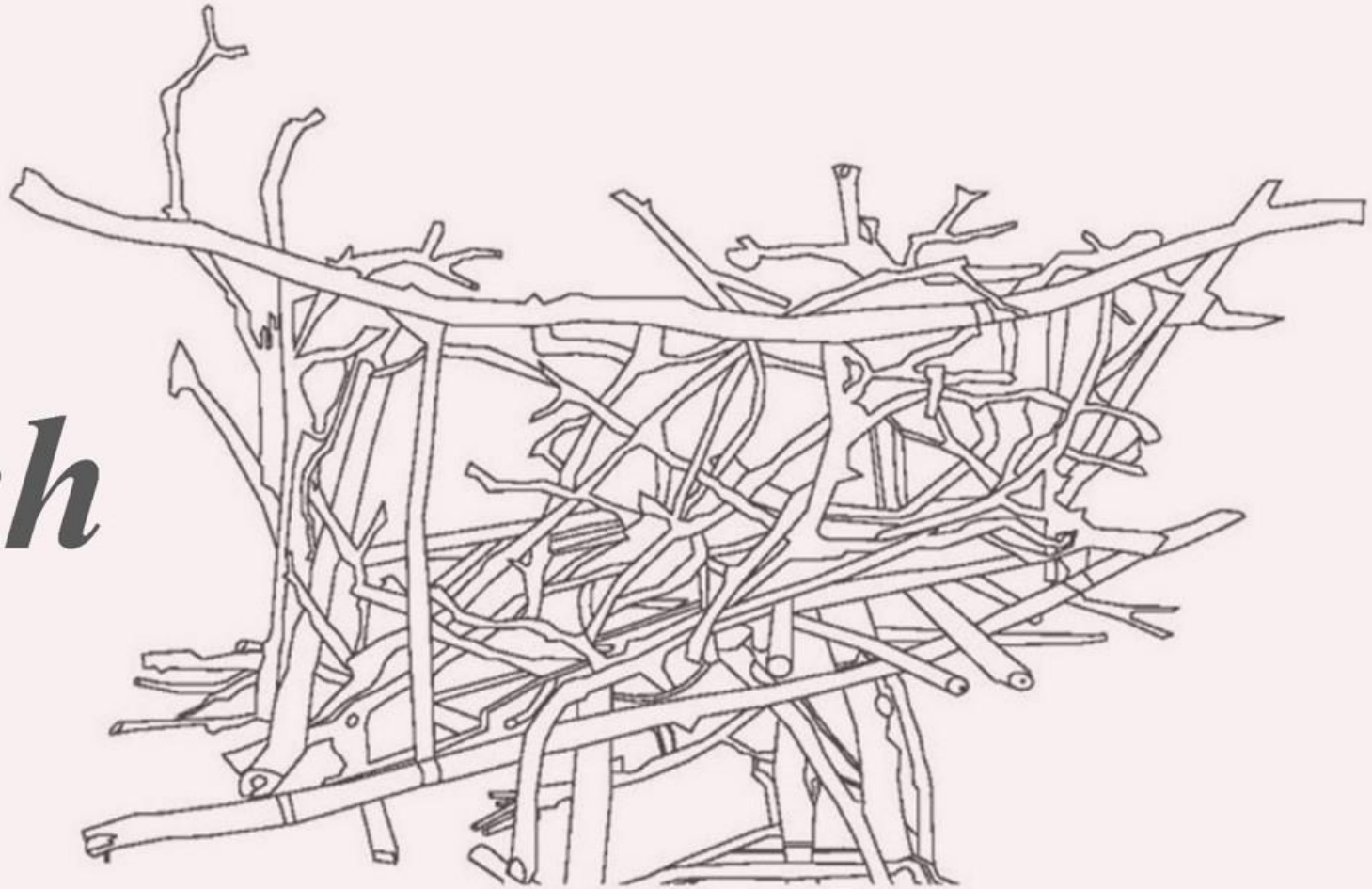
It was a beautiful sunny day, and I sat under a tree to admire the landscape of the Bronx in New York City. I was in my world of numbers, surrounded by the beauty and logic of nature.

I immediately observed the disconnected tree branches on the grass. These branches were missing elements of an existing fractal system. I saw an original design in them, with a different form and function, expressing a new beauty and logic of numbers.



I saw numbers; I saw shapes. I saw the beauty and logic of trees. I saw Yafreisy's Fractals!

Tree-Branch Chair



I saw the real branches multiplying, and the imaginary branches completing the shapes of the spaces satisfying Yafreisy Axioms designing my Tree-Branch Chair!

Yafreisy Axioms

1. *Two or more branches give a space its shape.*
2. *A shape is a close complete space.*
3. *When branches do not intersect, the shape is completed by an imaginary branch, called* $\mathfrak{b}_i$ *which is equal to -1.*
4. *Intersecting branches that close a space do not use an imaginary branch,* $\mathfrak{b}_i = i^2 = -1$ *because the shape is complete.*
5. *An extending branch can be shared with other branches to complete other shapes, even if the branch is imaginary.*

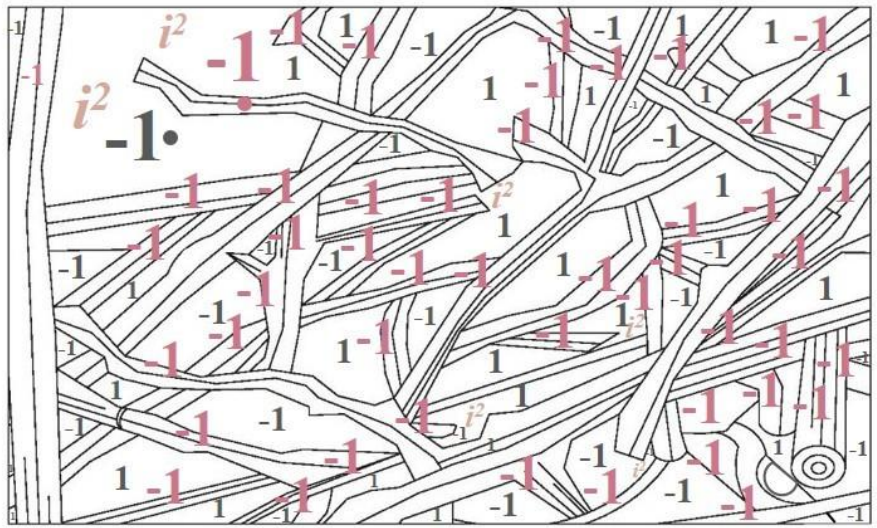
I gathered the real branches after the Yafreisy Set Formula computed the numerical values of my chair's elements.

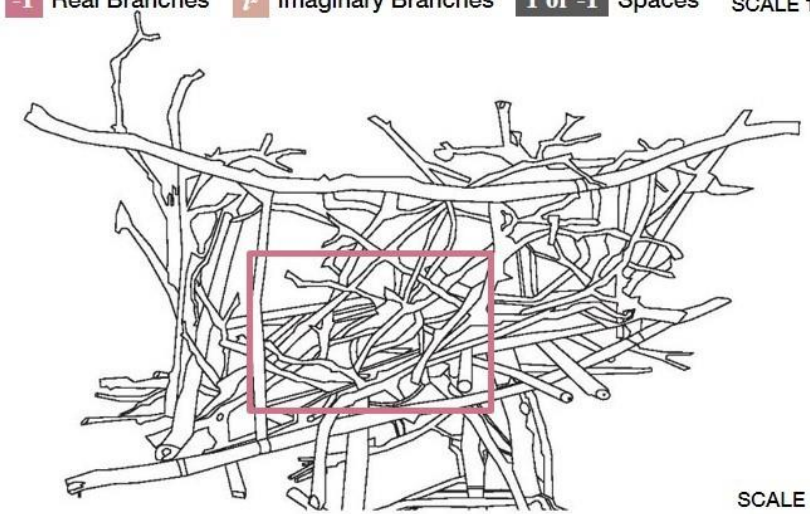
Yafreisy Set Formula

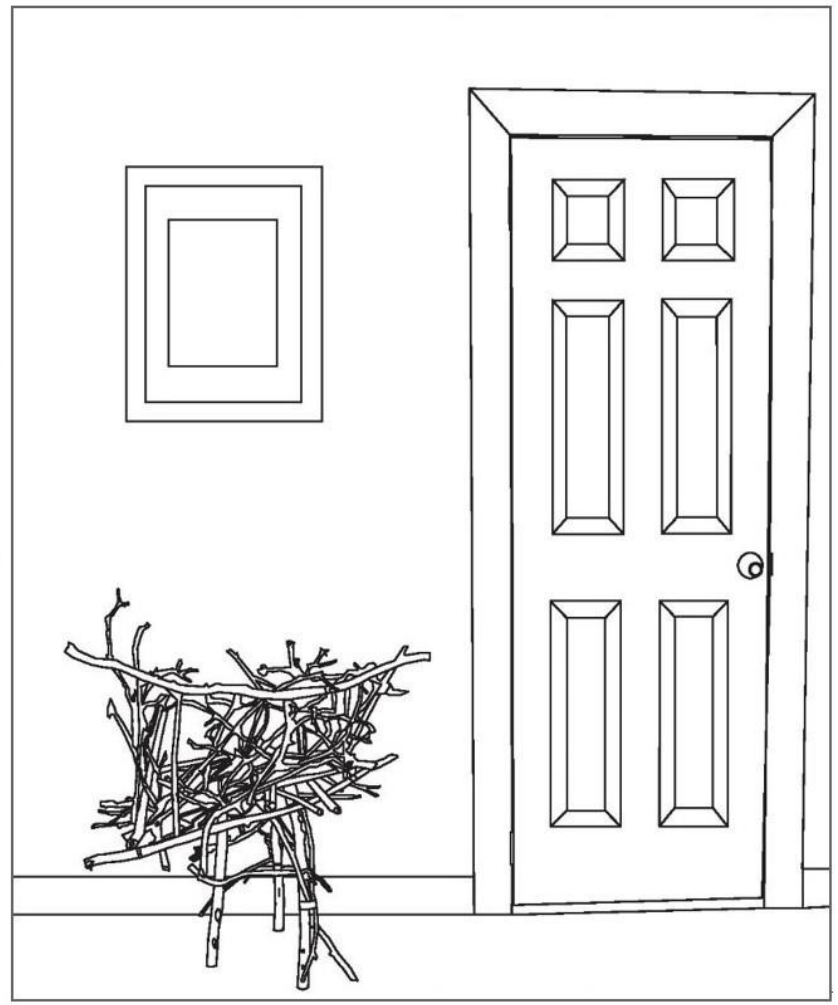
$$y = b^{n} \times (b_{i})^{n_{i}}$$

b = -1 = value of real branches.
n = number of real branches.
$b_i = i^2 = -1$ = value of imaginary branches.
n_i = number of imaginary branches.
y = value of space.

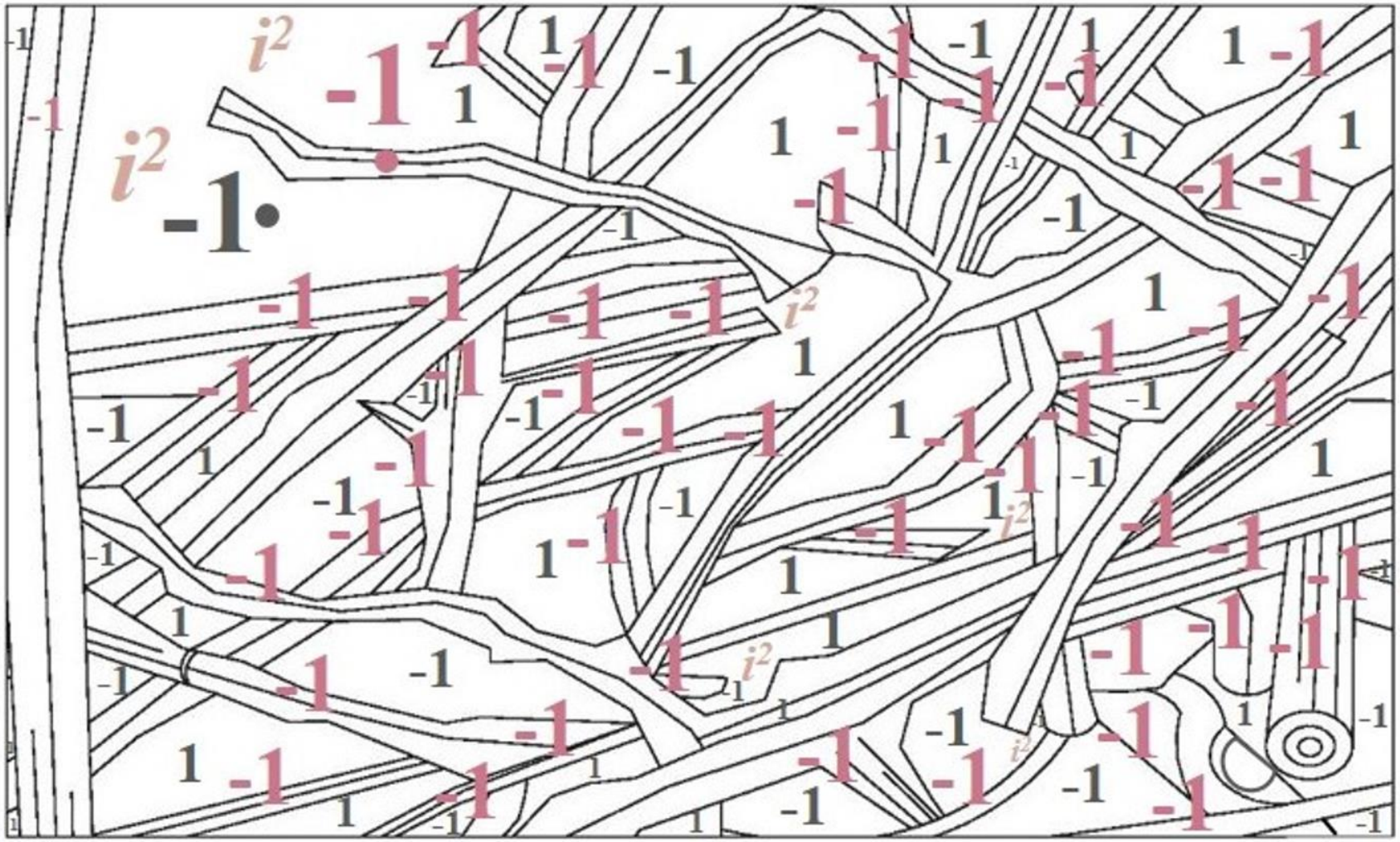
The values of the imaginary branches were $i^2 = -1$, the real ones were -1, and the spaces were 1 or -1.



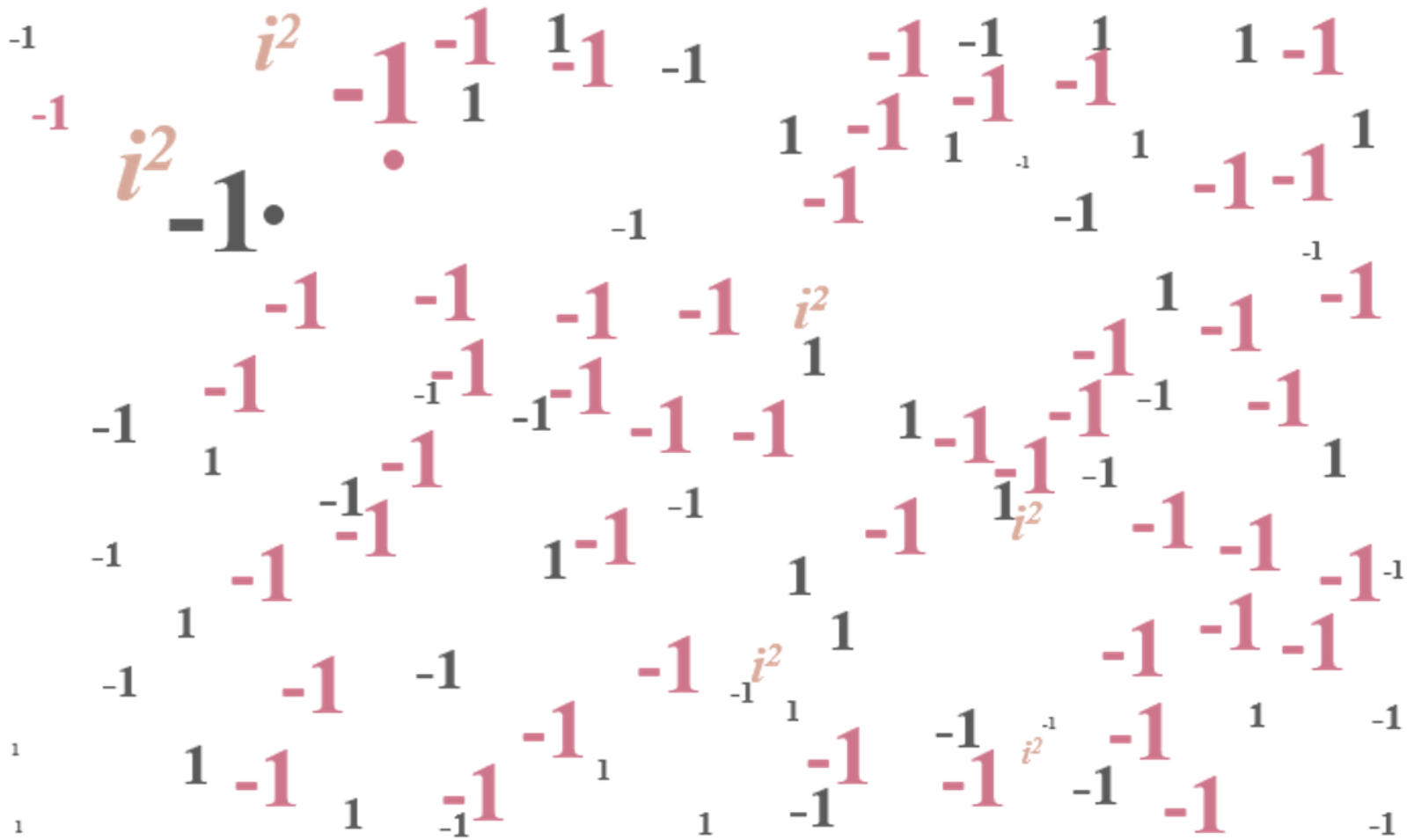




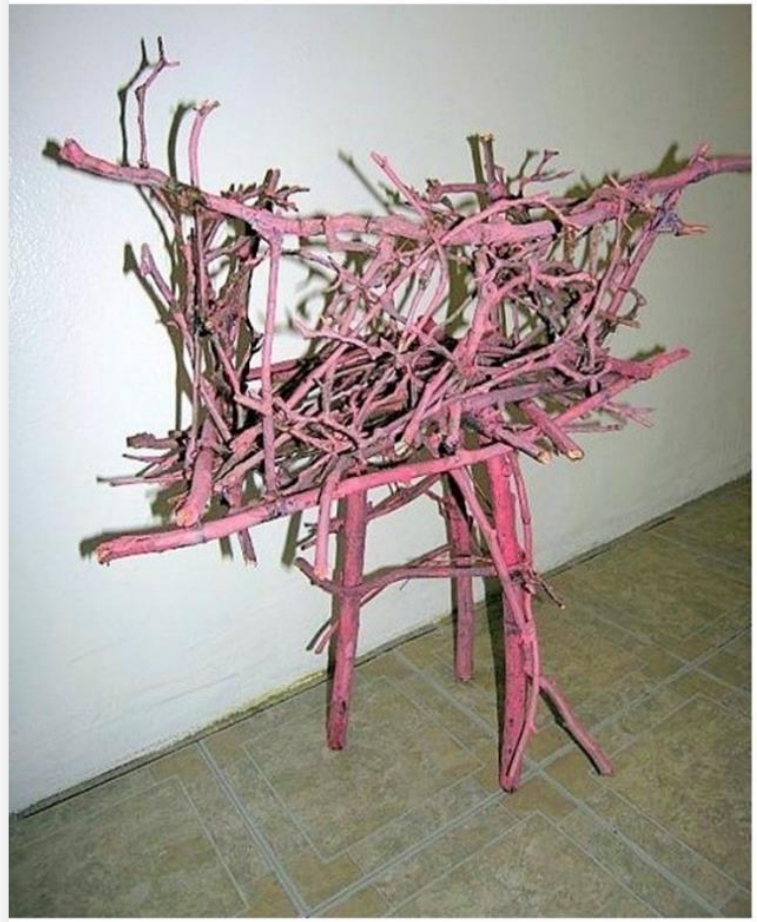
I started building my chair in this section; by mathematically weaving the real branches together, still seeing the imaginary branches and the beauty and logic of the numbers.



-1 Real Branches i^2 Imaginary Branches 1 or -1 Spaces



This is my Tree-Branch Chair!

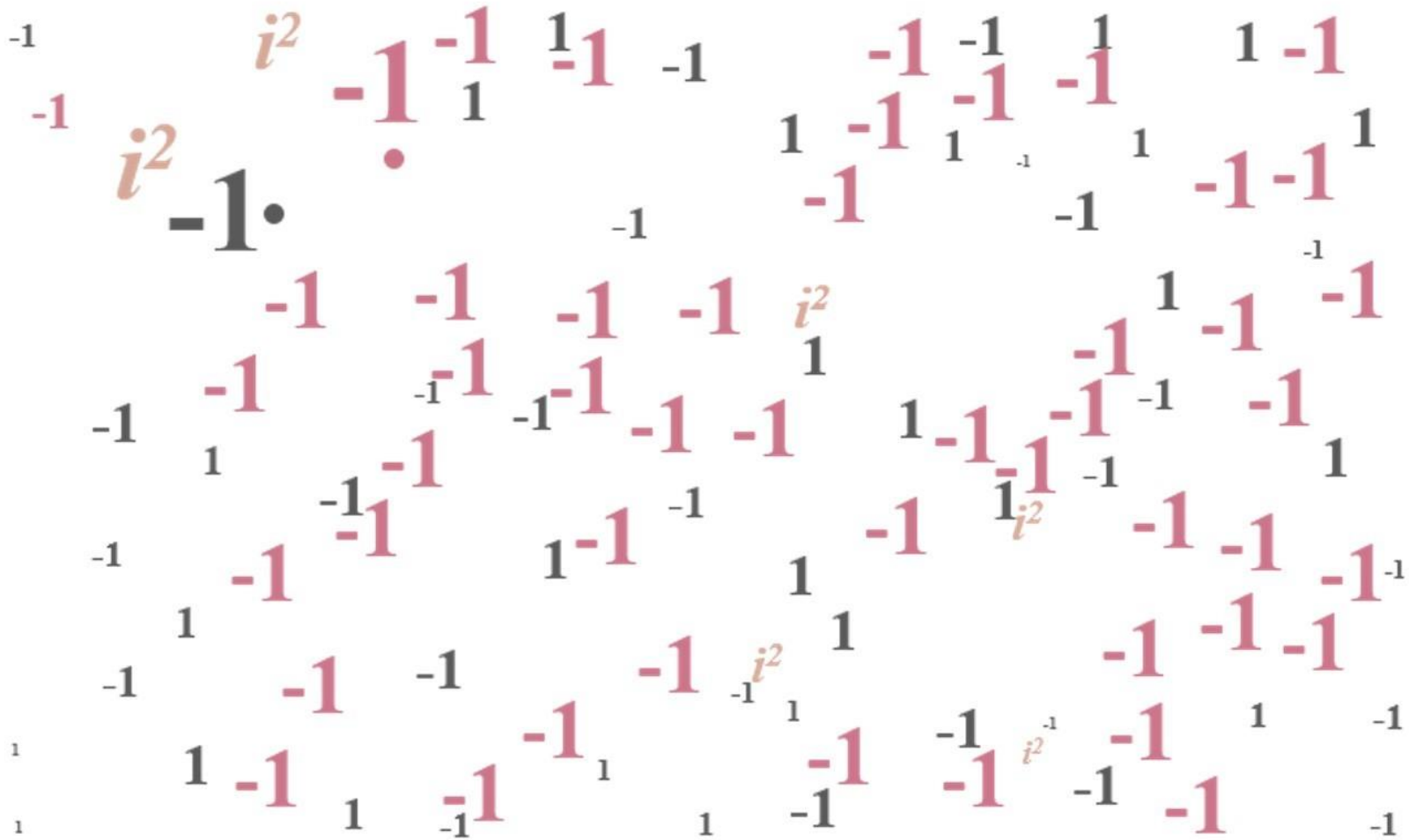


The self-similarity action of my chair's elements is Yafreisy Fractals!

The Landscape Mathematics design of my Tree-Branch Chair contains groups with elements mimicking each other's fractal system: 1) the real branches, 2) the imaginary branches, 3) the geometry of their spaces, and 4) the sequence of their numerical values.

Yafreisy Fractals are symmetrically designed groups, also satisfying group axioms!

The product of my chair's logic created geometric designs revealing more fractal systems as my hands satisfy group axioms with the movement of its elements.



-1 Real Branches i^2 Imaginary Branches 1 or -1 Spaces

Group Theory is the study of groups!

In Group Theory, to qualify as a group, the elements in the set and the operation such as addition (+), subtraction (–), division (÷), or multiplication (·) must satisfy conditions, called group axioms.

Group Theory Axioms, see *References*.

Let G be a set and let • be a binary operation defined on G. Then (G, •) is a group if the following four axioms G1 – G4 hold.

Group Theory Axioms, see *References*.

G1. *Closure*, for all $g_1, g_2 \in G$, $g_1 \bullet g_2 \in G$.

G2. *Identity*, there exists an identity element $e \in G$ such that, for all $g \in G$, $g \bullet e = g = e \bullet g$.

Group Theory Axioms, see *References*.

G3. *Inverses,* for each $g \in G$, there exists an inverse element

$$g^{-1} \in G \text{ such that}$$

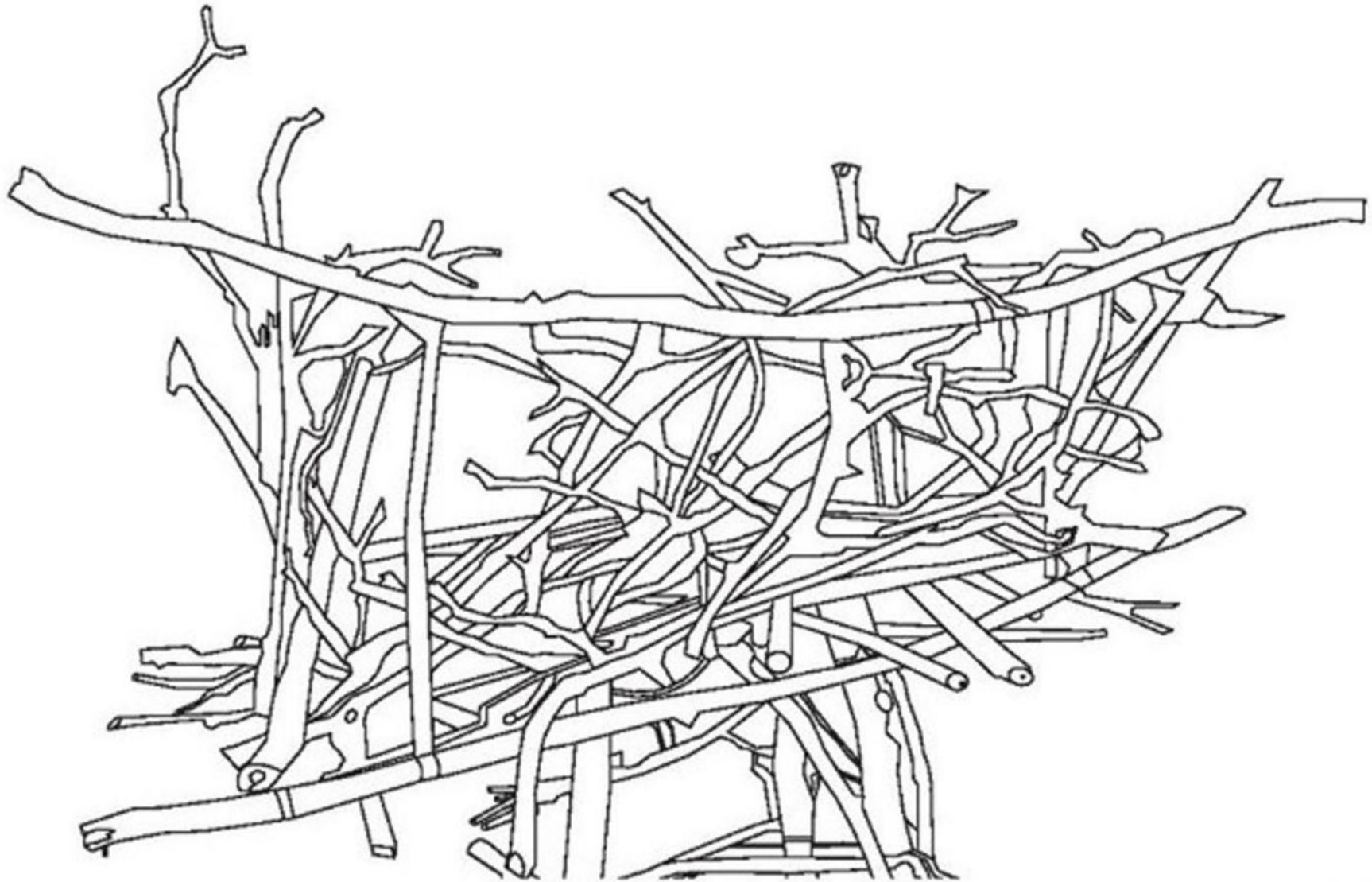
$$g \bullet g^{-1} = e = g^{-1} \bullet g.$$

G4. *Associativity,* for all $g_1, g_2, g_3 \in G$,

$$g_1 \bullet (g_2 \bullet g_3) = (g_1 \bullet g_2) \bullet g_3.$$

Group Theory Axioms, see *References*.

The geometry of my Tree-Branch Chair satisfies group axioms!



Tree-Branch Chair, 2008.

1. It has an *identity*, not changing the branches or the shape of its spaces.

2. It has an *inverse*, by reversing the branching pattern, the branches and its spaces return to their

original position.

3. It is *closed* because simple branching patterns combine to form more complex branching systems and spaces.

4. It has *associativity* because different moves together, but in the same order, does not change the branching pattern, or the fractal system of its spaces.

The numerical values of my Tree-Branch Chair satisfy group axioms!

Let's start with closure!

G1. *Closure,* for all g1, g2 ∈ G,
g1 · g2 ∈ G.

a) Therefore, g1 = 1, g2 = 1 :=
(1 · 1) = 1 ∈ G.

b) Therefore, g1 = 1, g2 = -1 :=
(1 · -1) = -1 ∈ G.

c) Therefore, g1 = -1, g2 = 1 :=
(-1 · 1) = -1 ∈ G.

d) Therefore, g1 = -1, g2 = -1 :=
(-1 · -1) = 1 ∈ G.

Result: My Tree-Branch Chair is closed under multiplication.

My Tree-Branch Chair is the replica of a tree's *crown* fractal system, and it is a group under multiplication.

I designed and built my Tree-Branch Chair in the Bronx in New York City in 2008.

My chair expresses Yafreisy Fractals, satisfying Yafreisy Axioms and group axioms, the Yafreisy Set Formula calculates the values of its elements, and the Yafreisy Set Algorithm translates its design.

Despite its different form and function, the aura of the tree continues to exist in its beauty and logic.

My chair's complex fractal system exists in the crown of trees, where the branches satisfy both Yafreisy Axioms and group axioms to receive the most sunlight for photosynthesis.

Behind all the chaos seen in the branching systems of trees, there is order, beauty, and logic in their design to existing.

Nature is a magical realm depicting the beauty and logic of the mathematics language.

Nature is a reflection of our actions. We need to acknowledge its laws of mathematics, so we can understand, and decode its message!

What I love about trees is that behind all their chaos, there is beauty and logic in their growth.

En la corona es donde crecen las ramas y las hojas de los árboles.

In the *crown* is where the branches and leaves of the trees grow.

Trees satisfy Yafreisy Axioms and group axioms with their branches to survive in this world of numbers.

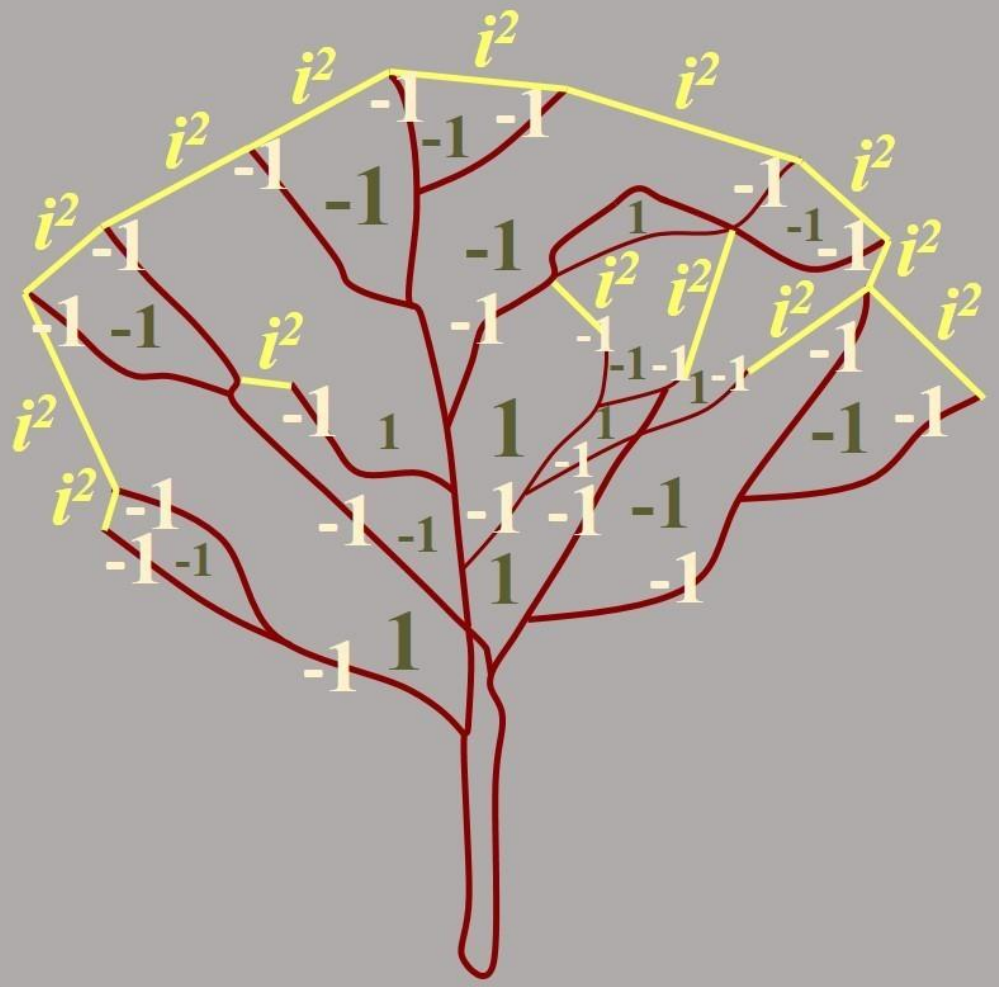
Humans do the same with their behavior using the same logic.

In trees, the position, size, and the number of branches determine the spaces' shape, and if they are positive or negative.

In the world, human behavior affects the location, size, and shape of their space; as a result, the multiplication of their actions determines whether they create positive or negative spaces.

If we create *la corona's* design with our actions, we can also learn how to travel and mimic its system to decrease the positive spaces.

Yafreisy Fractals



-1 Real Paths i^2 Imaginary Paths 1 or -1 Spaces

Si creamos el diseño de *la corona* con nuestras acciones, también podemos aprender a viajar e imitar su sistema para disminuir los espacios positivos.

We mimic nature, and nature mimics us.

Results

As a Landscape Mathematician, when I observe nature, concepts and visualizations form in my brain, and systems start to connect mathematically. I see the unseen laws of this beautiful world of numbers, and I create original algorithms, decoding, and mimicking nature's Landscape Mathematics systems.

My Tree-Branch Chair is the replica of a tree's *crown* fractal system. It expresses Yafreisy Fractals and satisfies Yafreisy Axioms and group axioms, the Yafreisy Set Formula calculates the values of its elements, and the Yafreisy Set Algorithm translates its design.

Despite its different form and function, the aura of the tree continues to exist in my chair's beauty and logic.

Trees are beautiful fractals of nature.

The Landscape Mathematics design of a tree contains four principal parts: 1) the roots, 2) the trunk, 3) the branches, and 4) its leaves. The crown is where the branches and leaves grow. Each part is a group expressing and using their fractal system separately; however, they mimic each other, they are connected, and they satisfy group axioms, creating the complexity of the tree's existence.

La corona **(the crown) is the result of the tree's complex system, where the branches, its main elements, grow systematically, creating and designing natural mathematical solutions with their number, size, and position, satisfying Yafreisy Axioms and group axioms for photosynthesis.**

In trees, the branches create a fractal system, the shape of their spaces mimics this logic, and the sequence of their numerical values creates a

fractal pattern—which is the complex product of Yafreisy Fractals.

When the branches multiply, they create spaces seen as shapes, satisfying Yafreisy Axioms.

Yafreisy Axioms

First Axiom. **Two or more branches give a space its shape.**

Second Axiom. **A shape is a close complete space.**

Third Axiom. **When branches do not intersect, the shape is completed by an imaginary branch, called b_i which is equal to -1.**

Fourth Axiom. **Intersecting branches that close a space do not use an imaginary branch, $b_i = i^2 = -1$ because the shape is complete.**

Fifth Axiom. **An extending branch can be shared**

with other branches to complete other shapes, even if the branch is imaginary.

Yafreisy Fractals are symmetrically designed groups, also satisfying group axioms.

Group Axioms

G1. Closure, for all $g_1, g_2 \in G$,

$$g_1 \bullet g_2 \in G.$$

G2. Identity, there exists an identity element $e \in G$ such that, for all $g \in G$,

$$g \bullet e = g = e \bullet g.$$

G3. Inverses, for each $g \in G$, there exists an inverse element

$$g^{-1} \in G \text{ such that}$$

$$g \bullet g^{-1} = e = g^{-1} \bullet g.$$

G4. Associativity, for all $g_1, g_2, g_3 \in G$,

$$g_1 \bullet (g_2 \bullet g_3) = (g_1 \bullet g_2) \bullet g_3.$$

The Yafreisy Set Formula calculates the value of the spaces created by the multiplication of the branches, which consist of the number of real and imaginary branches that form the shapes; the formula determines if they are positive or negative.

Yafreisy Set Formula

$$y = b^n \times (b_i)^{n_i}$$

n = number of real branches, b = value of real branches, b_i = value of imaginary branches, n_i = number of imaginary branches, and

y = value of space.

The Yafreisy Set Algorithm shows the connection between the fractal groups of the real branches, imaginary branches, their spaces, and the numerical sequences of their values, mimicking

each other's fractal logic.

The real branches are -1, and the imaginary ones are $i^2 = -1$. The branches have the same numeric values but with different characteristics.

The value of the spaces (1 or -1), is calculated using the Yafreisy Set Formula, counting the number of real and imaginary branches creating the shapes, and the size is dependent on the branches' position.

Trees branching patterns shows that an even number of branches, such as when $n + n_i = 2, 4,\ldots$, where n = number of real branches and n_i = number of imaginary branches, produce positive spaces.

Therefore, an odd number of branches, where $n + n_i = 3, 5,\ldots,$ where n = number of real branches and n_i = number of imaginary branches, produce negative spaces.

The imaginary branches (n_i) complete the shape of the spaces. When n = 2, and n_i = 1, we are counting three branches (two real and one imaginary), then the value of the space is negative; compared to when n = 2, and n_i = 0, we are only counting two branches (two real and zero imaginary), and the value of the space is positive.

If the numbers multiply, the branches multiply.

The number and distance of the branches is the key: *The number of real and imaginary branches determine the value of the spaces and property of their shapes.*

If the branches multiply, the spaces multiply.

The value of the spaces is the key: *The multiplication of the shapes' values determines if the design of the tree's corona is positive or negative.*

• In the crown, trees create various branching patterns with positive and negative spaces.

• There is a correlation between the design of la corona and the number of sunlight trees receive for photosynthesis.

• Compared to younger trees, older trees design more large negative spaces with their branches.

• Overall, there are more odd large negative spaces toward the exterior of a tree's crown than in its interior design.

• The age, species, and environmental conditions of trees are significant factors influencing their branching and behavioral system.

The Laws of Landscape Mathematics

***First Law*. Mathematics is the language of nature. If you understand nature, you understand mathematics.**

***Second Law*. Nature already uses the language of mathematics, so why not work with the environment instead of against it. We need to start mimicking the mathematical logic that occurs in the landscape, identify existing systems, and out of those concepts create new ones.**

***Third Law*. The moment you start to recognize and understand that mathematics is the language of nature, and *see* the *unseen* laws of this beautiful world of numbers, and mimic its logic**

to create original systems, you are a Landscape Mathematician.

1 | The Mathematics Language

Learning the language of mathematics is relearning what we already know. We should not fear what we know or even the unknown.

Mathematics is our first language.

Our knowledge and understanding of mathematics exist within us.

We are a product of love, beauty, and logic, and we communicate using numbers. We are connected and created mathematically.

When our living environment does not provide the necessary resources to survive, we create solutions

with nature. We mimic nature by designing with its laws of numbers.

We mimic nature, and nature mimics us.

Mathematics is the language of nature.

Mathematics is not an endangered language because its beauty and logic surround us.

We live in a world of mathematical solutions.

We are Landscape Mathematicians!

2 | Design and Education

The mathematical beauty and logic of this world is always evolving.

Some people do not want to acknowledge the importance of mathematics in design and education, and its existence in nature.

When the reality is, we design with numbers subconsciously. We use mathematical systems to teach, learn, and function every day. It is natural for us to use numbers.

Mathematics is the language of nature. We have an intrinsic connection with nature. We mimic what we see in the landscape and design solutions.

The younger generation must understand that they are learning and communicating with numbers, or the effects of thinking otherwise will continue onto adulthood.

Most importantly, we should never hide our knowledge or talents in mathematics.

We need a world where everyone can express their love for mathematics and live without fear of numbers. A world that mimics nature and creates original systems and advances with beauty and logic. This Landscape Mathematics offers.

3 | Landscape Mathematics

Landscape Mathematics = Landscape Architecture + Mathematics + Engineering™.

Landscape Mathematics is an interdisciplinary STEM field that combines knowledge in landscape architecture, mathematics, and engineering used to design, build, and perceive this world of numbers.

Landscape Mathematics teaches how to recognize and understand the seen and unseen beauty and logic of this world of numbers.

Nature already uses the language of mathematics, so why not work with the environment instead of against it. We need to start mimicking the mathematical logic that occurs in the landscape,

identify existing systems, and out of those concepts create new ones.

To solve the unimaginable problems of the world, we must learn to decode and recognize what we see in nature.

Landscape Mathematics is the key to design and education, and our existence in this world of numbers.

The world is Landscape Mathematics.

4 | Landscape Mathematicians

Landscape Mathematicians are a force of nature.

Landscape Mathematicians, *Matemáticos Paisajistas*, are mathematical thinkers, designers, philosophers, scientists, and inventors, and can easily recognize and understand the beauty and logic of this world of numbers.

Landscape Mathematicians are the bridge of knowledge between humans and nature.

Mathematics is our first language! By translating the systems we see in colors, shapes, and numbers, we reveal the logic of this beautiful world.

Landscape Mathematicians see a world of numerical solutions. We see a world of Landscape Mathematics.

Many people do not know that they are Landscape Mathematicians, even when they understand and communicate with nature mathematically or reveal nature’s logic and express it with their creativity.

There are different types of Landscape Mathematicians in the world, but we are all multitalented individuals with the gift to recognize and understand the seen and unseen laws of mathematics.

Landscape Mathematicians understand how the world functions. We design and create the laws of this world of numbers, maintain the peace between humans and nature, and create innovative solutions with our futuristic originality.

Landscape Mathematicians are the change that

humanity and nature desperately need. We are the common denominator in all fields of the world.

5 | Knowledge

When we investigate and analyze different city's urban systems and the environmental factors that affect them, we start to observe patterns.

My first Landscape Mathematics global Project: Roof-Wall-Landscape Matrix Network™ is the combination of landscape architecture, mathematics, and engineering. My Project is a unique, complex design consisting of a sequence of Roof-Wall-Landscape Systems' within a larger Roof-Wall-Landscape Matrix Network™ that mimics mathematical landscapes. I recognized the concept of matrices in group theory in the favela landscapes of Brazil. When applying sequences of my Roof-Wall-Landscape System™ to each favela home, it creates a matrix neural network that improves green infrastructure, stormwater management, water quality, and reduces flood hazards for the community as a whole and the world.

One of its components is Carrero 3x3™, the Roof based mathematical natural water filtration system that gives access to potable water, maximizes food production, collects water, and reduces stormwater runoff. It creates a self-sustaining cycle, using concepts found in mathematics, physics, geography, biology, landscape architecture, and engineering.

The underserved communities of the world deserve to have stronger education and healthier mathematical environments.

6 | Yafreisy Fractals

Our brain functions using fractal geometry; the dendrites of neurons resemble the branches of trees; our thinking mechanism and actions form fractal systems; clouds express fractal patterns, and lightning sparks and leave its fractal fingerprints on the landscape. The mathematical logic of this beautiful world of numbers surrounds us. Fractals are everywhere. Symmetry is everywhere.

Fractals are patterns of chaos, but they have order and a central point to their creation.

Fractals are magnification symmetry. They express beautiful and logical sequences of self-similarity at different scales forming groups.

Trees are beautiful fractals of nature.

The Landscape Mathematics design of a tree contains four principal parts: 1) the roots, 2) the trunk, 3) the branches, and 4) its leaves. The crown is where the branches and leaves grow. Each part is a group expressing and using their fractal system separately; however, they mimic each other, they are connected, and they satisfy group axioms, creating the complexity of the tree's existence.

La corona is the result of the tree's complex system, where the branches, the main elements, grow systematically, creating and designing natural mathematical solutions with their number, size, and position, satisfying Yafreisy Axioms and group axioms for photosynthesis.

In trees, the branches create a fractal system, the shape of their spaces mimics this logic, and the sequence of their numerical values creates a fractal pattern—which is the complex product of Yafreisy Fractals.

Humans and nature design Yafreisy Fractals.

7 | Humans and Nature

Trees behave based on the environmental factors that affect them. They demonstrate this beauty and logic with their branches in the crown. Trees always survive, and humans do the same using the language of mathematics.

Trees create fractal branching patterns in the crown.

Humans create fractal systems in the world.

Trees satisfy Yafreisy Axioms and group axioms with their branches to survive in this world of numbers.

Humans do the same with their behavior using the same logic.

In trees, the position, size, and the number of branches determine the spaces' shape, and if they are positive or negative.

In the world, human behavior affects the location, size, and shape of their space; as a result, the multiplication of their actions determines if they are creating positive or negative spaces.

En la corona es donde crecen las ramas y las hojas de los árboles. Los humanos imitan la ramas de los árboles con sus acciones para sobrevivir en este mundo de números.

Humans mimic the branches of trees with their actions to survive in this world of numbers.

If we create *la corona's* design with our actions, we can also learn how to travel and mimic its system to decrease the positive spaces.

We mimic nature, and nature mimics us.

Conclusion

Patterns are recognized as mathematics worldwide. Nature communicates with us mathematically. We need to decode its message.

Nature’s reaction is a reflection of our actions.

We mimic nature, and nature mimics us.

To solve the unimaginable problems of the world, we must learn to interpret and recognize what we see in nature.

Landscape Mathematics is the key to design and education, and our existence in this world of numbers.

In our world, we advance with beauty and logic.

In times of chaos, we acknowledge our true selves. We connect with our first language. We reveal the

truths of mathematics by communicating with numbers and increasing the number of mathematical solutions globally. We discover the beauty and logic of our world!

We design with numbers as Landscape Mathematicians!

We reveal our world as Landscape Mathematics!

The complete and original text appears in *Landscape Mathematics, Design with Numbers* by Yafreisy Carrero.