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Fractals between “La nuit étoilée”, “# 8”, and an eglantine rose: A linguistic insight in transdisciplinarity

Fractais entre “La nuit étoilée”, “# 8” e uma rosa eglanteria: uma visão linguística desde a transdisciplinariedade

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Resumen

En este artículo nos proponemos entrelazar ciertos rasgos estructurales en dos obras de arte "La nuit étoilée" (1889) de van Gogh, exhibida en el Musée d'Orsay, y "# 8" (1949) de Pollock, actualmente expuesta en el Museo Neuberger, en la Universidad del Estado de Nueva York. Seguidamente, aplicamos los mismos rasgos para analizar una flor natural, la eglantina (*rosa rubiginosa*), que crece generalmente salvaje en climas templados y subtropicales tanto en Europa como en Asia. Con el fin de lograrlo, partimos de conceptos básicos de la teoría del caos (Mandelbrot, 1982): los relativos a fractales, iteración y autosemejanzas. Recurrimos también a la teoría de los tres cuerpos de Henri Poincaré (2007) y al manifiesto de la transdisciplina de Nicolescu (2002). Al mismo tiempo, abordamos una serie de artículos recientes provenientes de los campos de la física y de las matemáticas que nos conducen a encontrar diferencias y semejanzas entre la flor natural y ambos lienzos. Finalmente, sugerimos que el entretejimiento entre arte, naturaleza y matemáticas también puede lograrse por medio de visualizaciones, metáforas, conceptos lingüísticos básicos y etimologías —un puente más entre las humanidades, el arte y las ciencias.

Palabras clave: fractales, arte visual, naturaleza, metáforas, lingüística, transdisciplinariedad.

Abstract

In this essay we first aim to interlace certain structural features between two masterpieces, van Gogh's "La nuit étoilée" (1889), exhibited at the Musée d'Orsay, and Pollock's "#8" (1949), currently shown at the Neuberger Museum, in the State University of New York. Secondly, we apply the same features to analyze a natural flower, the eglantine rose (*rosa rubiginosa*) that usually grows wild in temperate and subtropical climates in Europe as well as in Asia. In order to do so, we draw on basic concepts from chaos theory (Mandelbrot 1982): From fractals, iteration and selfsimilarity. We also resort to Henri Poincaré three-body theory (2007), and to Nicolescu's manifesto of transdisciplinarity (2002). At the same time we address a series of recent research articles from the fields of physics and mathematics conducing us to find differences and resemblances between the natural flower and both canvases. Finally, we suggest that the intertwining between art, nature and mathematics can also be realized by means of visualizations, metaphors, basic linguistic concepts and etymologies —a new bridge between humanities, art and sciences.

Key words: fractals, visual art, nature, metaphors, linguistics, transdisciplinarity.

Resumo

Neste artigo, propomos entrelaçar certos rasgos estruturais em duas obras de arte "La nuit étoilée" (1889) de van Gogh, exposta no Musée d'Orsay, y "#8" (1949) de Pollock, atualmente presente no museu de Neuberger, na Universidade do Estado de Nova York. Em seguida, aplicamos os mesmos rasgos para analisar una flor, a eglantine (*rosa rubiginosa*), que cresce geralmente selvagem nos climas temperados e subtropicais, tanto na Europa como na Ásia. Com este objetivo, partimos de conceitos básicos da teoria do caos (Mandelbrot, 1982): fratais, iteração e autosemelhanças. Recorremos também a teoria dos tres corpos de Henri Poincaré (2007) e ao Manifesto da transdisciplina da Nicolescu (2002). Ao mesmo tempo, abordamos uma série de artigos recentes produzidos nos campos da física e das matemáticas que nos conduzem a encontrar diferenças e semelhanças entre a flor natural e ambas pinturas. Finalmente, sugerimos que o entrelaçamento entre arte, a natureza, e as matemáticas também pode conseguir-se por meio de visualizaçãos, metáforas, conceitos lingüísticos básicos e etimologias —uma ponte mais entre as humanidades, a arte e as ciências.

Palavras chave: fractais, arte visual, natureza, metáforas, lingüística, transdisciplinariedade.

Mathematics, rightly viewed, possesses not only truth

but also supreme beauty –a beauty…like that of sculpture.

Bertrand Russell

With a fractal i, you look in and in and in,

And it always goes on being a fractal,

It's a way towards a greater awareness of unity.

David Hockney

Big whorls have little whorls /

Which feed on their velocity, /

And little whorls have lesser whorls /

And so on to viscosity.

Lewis F. Richardson

Introduction [ii]

This essay wanders if exploring fractals between art, mathematics and nature can be done by means of basic visualizations, metaphors and basic linguistic notions. Therefore we resort to predominant facets originated in chaos theory (Prigogine and Stengers, 1984) and in transdisciplinary research (Morin, 1989; Nicolescu, 2002). The article comprises three main sections: In the first section, we review an interdisciplinary article on van Gogh's swirling motifs published in a highly recognized journal of mathematics and image (Aragon, Naumis, Bai, Torres and Maini, 2008). These authors apply the thermodynamics phenomenon of *turbulence* to several van Gogh masterpieces, in particular to "La nuit étoilée" (1889). In the second section, we examine a series of published discussions for authenticating Pollock's dripping oeuvres via the fractal dimension, particularly those concerning Pollock' canvas "# 8", a work of art signed in 1949 (Coddington, Elton, Rockmore and Wang, 2008; Taylor, Micolich and Jonas, 1999; Taylor, Guzman, Martin, Hall, Micolich, Jonas, Scannell, Fairbanks and Marlow, 2007; Zheng, Nie, Meng and Feng, 2014). In the third section, by means of bi/multipolar coordinates, we apply a quite special fractal dimension to a natural jewel, an eglantine rose, arguing that fractals (Mandelbrot, 1982) as well as other principles from chaos theory and from transdisciplinarity offer a prime path for humanistic and art studies [iii]. Needless to say, we derive the interlinking research process along the three sections from the three-body-theory (Poincaré, 2007) [iv]. Besides, we resort to language structures and to discursive figures, traversing metaphorization, etymology, comparison, analogy, semantics, and other linguistic fundamental recourses as a procedure to approach the artistic van Gogh and Pollock uniqueness, from humanities though.

Thence, shall we take a step towards "La nuit étoilée*"?*

"La nuit étoilée"

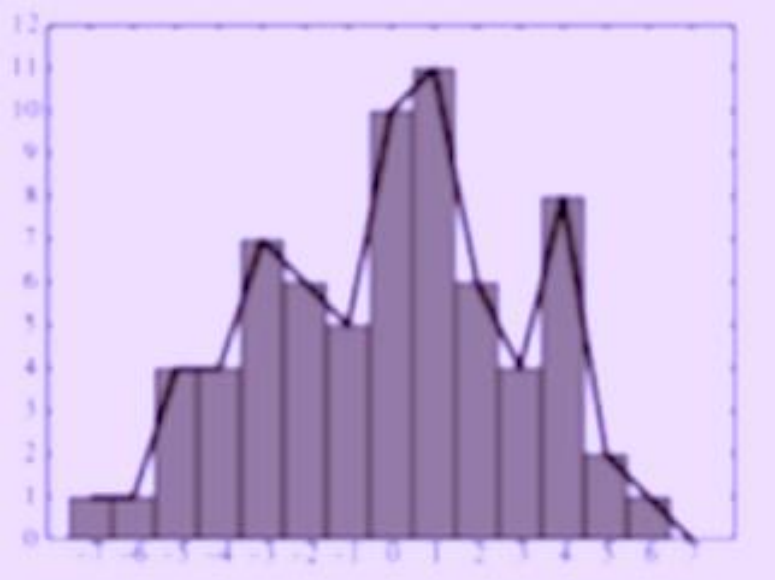
Luminance

In this section, we depart from the linguistic sign *luminance* used in thermodynamics to describe the special effects of light when the temperature diminishes. Not surprisingly, luminance twinkles in several artistic canvas, mainly in impressionist works where it represents a predominant constitutive characteristic of an evolutionary shift in art. Van Gogh joined impressionists and fauvists when he was living in Paris. In consequence, this experience left a profound mark on his canvas. It also motivated him to move south in search of the translucent and warm Provence countryside, expressly seeking the purest luminosity particular to that region. Once there, among numerous Arles landscapes and scenes, he painted "La nuit étoilée" under

the bluest and warm skies over the small village of St. Rémi, where he spent his last years and where he was buried as he had requested of his brother Theo.

Therefore, and not trivially, the issue of *luminance* in both of the fields of art and physics, and mainly the intrinsic semantic elasticity of linguistic signs tell us that taking a concept from one linguistic context or from any scientific configuration and transferring it into another may transform its usually expected literary meaning. Besides, the new contextualization might open a surprisingly handy and novel space to be approached from a transdisciplinary perspective. So far, Aragon *et al.* define *luminance* as "a measure of the luminous intensity per unit area" (2008, p. 276), referring to the method of tracing a net of squares with vertical as well as horizontal lines on a screen and zooming in to appreciate pixels variations. In this way, they obtain the values of *luminance* from the following algorithmic formulation: $299\ R + 0.587\ G + 0.114\ B$, where *R*, *G* and *B* stand for red, green and blue respectively (p. 276). Moreover, they clearly trace the lows and highs in "La nuit étoilée" *luminance* intensity by means of the histogram below (Image 1):

Image 1.



Histogram of luminance differences measured in pixels

This way, we appreciate that the phenomenon of *luminance* is depicted in the field of physics by means of a computational processing formula, which represents the light variations generated with paint and brush strokes by van Gogh when light waves are transferred to the field of visual art.

Turbulent

In regard to the adjective *turbulent*, Aragon *et al.* remark: "many art critics have borrowed terms evoking concepts that arise in scientific disciplines" (p. 275) [v]. Although it would be difficult to find out from which discipline the term *turbulen*t merged first, the linguistic observation offered by these authors allows us to value again the central dynamicity of language which roughly consists of transferring, for example, *semas* [vi] from one linguistic sequence or paradigm to another, from one language to another, from one discursive genre to another, from one period of language use to another, from a technological device to another, from one scientific field to another [vii].

Thus, let's return to the extrapolation of *turbulent*, and we might find that it is not trivial at all, be it a borrowing from the field of physics or from the field of humanities or social sciences or perhaps vice versa. In addition, there may be the need to resort again to linguistics when Aragon *et al.* hasten that the mathematical approach offers "scientific objectivity*"* to judge art (p. 275) [viii]. Perhaps it could be more suitable to say, according to a transdisciplinary perspective, that a third reality might emerge from the overlapping of objectivity and subjectivity. Not to mention, the logic of the third included (Lupasco, 1987; Morin, 1989; Nicolescu, 2002; Serres, 1992; Zadeh, 1975) allows us to avoid the alternative between scientific and not scientific, between objective and subjective. Moreover, when refusing dualities, we might discover a cognitive universe offering perhaps infinite variations where experiencing/learning/knowing are relative, never absolute, and unpredictably manifold. That is, neither objectivity nor subjectivity seems perfect, homogeneous or conclusive; besides, they constantly modify each other and are nourished by inconstant peripheral intakes. Let's examine an example in the art world: Abstract art is usually considered as more objective when compared with realistic art. Shouldn't we rather say that the former could be considered nearer to Euclidian geometry and our classical way of measuring than the latter? Thereby the dividing lines between both qualities, subjective and objective, could be relatively blurry, opening a multilayered presence of either one. Added to the previous linguistic annotations, we intend to suggest the existence of *fuzzy* lines between art and physics. Zadeh, a prestigious mathematician and computer scientist, brought about the term *fuzzy* (1975), and we could associate it with the woolly warm of energy, its dispersion, its variation, and all its complex paths so difficult to perceive.

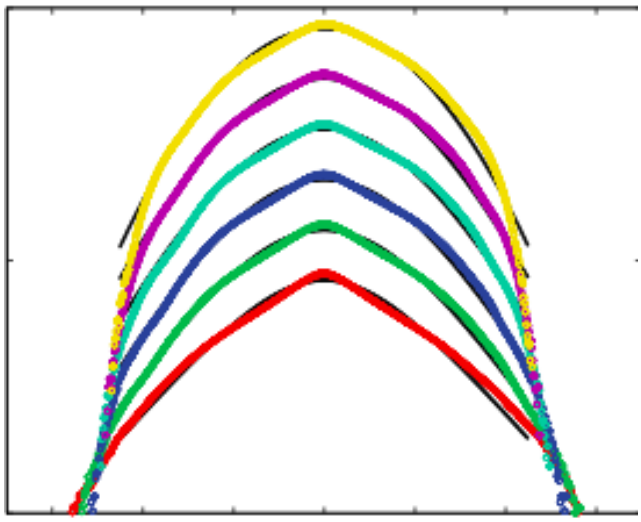
Now then, it is perhaps pertinent to point out that physics has been named after *φυσις*, borrowing the word from Greek, meaning *nature* (Bailly, 1950*)*. In fact, physics analyses, describes and theorizes phenomena of nature; but so does art. Thus physics and art share many common aspects and it might be pertinent to remember that several cultures tend to consider that nature comprises fauna, humans, and flora, interlaced and on the same level of importance [ix], without conceiving humans' superiority over the

other animated beings. Then, a transdisciplinary perspective opens up our minds to elasticity, flexibility, versatility, adaptability, and expansion, as well as to a certain tolerance towards *difference* (Derrida, 1979) and variation.

Luminance variances

The Gaussian curves below (Aragon *et al.* 2008, p. 278) constitute indeed a representation of variation (Image 2).

Image 2.



"Function of pixel variation luminance fluctuations of the overall image "La nuit étoilée"

We notice here again the undoubted existence of variance in the field of *luminance.* Therefore the density of variance offers a handy observation and constitutes a method of representation we could apply to any dynamic and evolutional phenomenon. An example of evolution at hand comes into sight in one language as well as in all languages; particularly in their constitutive polysemy, development, social, spatial and chronological changes, also in bi- and multilingualism, and in all characteristics one perceives from a cross-language cultural view. Moreover when we interact with different interlocutors and in new situations, we vary slightly the volume, pronunciation and even signification of the communicative encounter. It goes without saying that the whole process modifies our identities as well. Thus, under van Gogh strokes of mustard, yellow, cream and gold, the stars vary, showing new nuances, sizes, volumes, and densities of light. Similarly, colors and coordinates in the Gaussian curves in Image 2 show large and small scales of *turbulence* velocities, densities and values; each scale forming a *fractal*, representing a dimension of luminance fluctuations in the overall image "La nuit étoilée".

Turbulent luminance

We have seen that *luminance* accounts, through all its possible variances, for a dynamic phenomenon that crosses both art and physics. In Vincent van Gogh's work we appreciate the variation [x] of *luminance* between stars, clouds, and cypresses; thus it seems that generation of fractals reflects a part of his style, as a signature. When looking more closely at the stars variant shapes, it could be possible to imagine that van Gogh generated them using a flat reed picked up in nature, or a bowed branch of a tree, or any other undetectable technique. Undoubtedly he also used brushes, but when reaching the final strokes it could be that he rubbed an old and nearly dirty rag in a circular movement over the skies, the tree canopies and the mountain slopes he had painted —aiming to create moving twirls, spins, and rotations, to produce movement, air and wind. He might have even done the same finishing gesture on the whole canvas, varying the pressure of his hand as well as the amplitude of the movement. The curly effects of all sizes and thicknesses seem to generate the nature elements though. But the original turbulent forms just alluded were often considered as socially and artistically displaced, even disruptive by his contemporary art critics and laymen. Only a few artists appreciated him, like his friend Gauguin. Creating wind in the middle of Provence landscape was perhaps regarded as a deranging and dramatic evocation of the furious blowing *mistral*, a frightening and cold wind particular to that region. In contrast, nowadays we appreciate the poetic spirals turning clockwise around and around themselves like pinwheels, like ludic *rehiletes* [xi], often seen in popular craftwork.

Impassioned

The most attractive term in Aragon et al. title, *impassioned*, certainly fits with van Gogh's art, and it appears most frequently in the context of human feelings, emotions, creativity, all elements where intensity is not usually defined with numbers and digital formulas; notably, the term *impassioned* might be rarely found in physics and mathematical publications. It is most appealing here indeed. Moreover, in everyday life, *impassioned* shares common meanings with words like *disturbanc*e, *disorder*, *entropy* these phenomena being pivotal issues that are studied in the field of physics, specifically in thermodynamics). Yet *impassioned* filters through van Gogh canvas and life, when he creates swirling clouds without discernible borders, or irregular undulations of light, or bending iris and cypresses under the wind −as if color was movement and time was going by. On top of that, let's recall the series of fading sunflowers "Tournesols" (1887-1888) which reflect the time passing by as if time, mind, nature, life and death made the painting; and time becomes a passion in van Gogh artwork.

On the one hand, metaphorization or the transfer of a linguistic sign or object to an strange context, in fact transforming its literal meaning, for example in the universal

metaphor *eyes are the mirror of the soul*, may mirror van Gogh's gesture when he transfers his passion in life, through twinkling strokes, to the arlesian stars. His painting transforms a literal two dimensions flat canvas into an infinitely glimmering starry night, as if spiral paint marks reflected van Gogh's uncontrollable emotion. Anyhow, the term *impassioned* may suggest a certain similarity between both the contexts of art and physics, and we are invited to interpret its use in Aragon *et al*. title "Turbulent Luminance in Impassioned van Gogh Paintings" as a blurry frontier between art and physics, breaking the line between both cognitive configurations.

To sum up, in the quite evocating, we have the term *luminance*, a main issue in physics as it deals with vibrations of light and at the same time designs one of the first artistic values and criticisms when judging pictorial art. It follows that when inserted in the phrase *turbulent luminance* it depicts different nuances in a context of physics or art. Finally, the word *impassioned* nerves vigorously the full sequence, generating the inevitable semantic fusion between the concepts 'turbulent', 'luminance' and 'impassioned', inviting us incidentally to read the article with curiosity looking for the extrapolations from an art configuration to a mathematics configuration. In such wise, the title is dense in metaphorization, dynamics, and creativity.

One more word: statistical theory

So far, Aragon *et al*. have entwined, interdisciplinary, the algorithmic palette as well as the Gaussian curves in the study of "La nuit étoilée". In addition, and not surprisingly, they bring about various complex algebra formulas, notably Kolmogorov's theory on velocity and *turbulent* fluids (pp. 276-277). Then they prompt the statistical *variances* on velocity and compare luminance in art with Kolmogorov's statistical theory, duly recognizing him as a founder of turbulence theory (pp. 276-277), which greatly supports their way of approaching art.

Image 3.

"La nuit étoilée" (1889)

Lastly, in "La nuit étoilée" skies, stars, clouds, and the moon crescent (or, using the French polysemous word, *croissant de lune* also applied to a viennoiserie pastry with the same shape) circled inside its tenuous gold halo, are practically dancing around in a fractal manner. Playing with alliteration between words of the same stem: The *variety* of variance between the various fractal dimensions of nature emerges across van Gogh's imaginative canvas while the hills seem to flow while the cypresses make a *pas de deux* under the wind. We now leave our short chronicle on Aragon *et al*. as well as on visualizing fractals in van Gogh, to enter, like ways through fractals, into Pollock's dripping and pouring abstract art.

From Fractal Dimension D to Pollock's "# 8"

From *turbulence* and *luminance* previously considered in art and mathematics in van Gogh's "La nuit étoilée," and possibly from *impassioned*, we now broach the fluid effects of Pollock's dripping and pouring paintings on innovative, humongous canvases, innumerable indeed, and resembling murals, yet created on the floor. Undoubtedly, like van Gogh, Pollock shares an incommensurable prestige in the art world. In particular, most art critics consider Pollock as a major artistic style founder of the abstract expressionism, sometimes called matteric movement [xii] on the other side of the Atlantic.

Expressly, Pollock became more abstract, expressionist, and matteric year after year; accordingly, we will talk mainly about his more chaotic and inventive period. Due to his visionary contrivance, a series of researchers from different countries have resorted to the ingrained fluidness offered in *The Fractal Geometry of Nature* (Mandelbrot, 1982), a scientific research territory originated in chaos theory, for detecting the authenticity of Pollock's complex masterpieces.

In particular, Taylor, in his "Fractal analysis of Pollock's drip paintings", along with two other young physics scientists, Micolich, and Jonas (1999), argues that there is a way to give an "objective" explanation of Pollock's art and they explain how they proceed to measure the fractal dimension *D* in his canvas:

To calculate the fractal dimension D, we cover the scanned photograph of a Pollock painting, "Alchemy" (1947), with a computer-generated mesh of identical squares and calculate the fractal dimension in the whole painting (p. 422) [xiii].

In 2008, Coddington, Elton, Rockmore and Wang continue to examine Taylor's *fractal* methodology and the calculation of the entropy dimension *D* in Pollock's stylometry:

> Mathematics, computer science, and statistics are beginning to play a larger role in the field of art history and connoisseurship. This is largely due to advances in imaging technology as now-days it makes possible the relatively inexpensive high resolution digital capture of a work of art. Once transformed to numbers, a work of art becomes a rich source of data, open to the methods of modern mathematics and computational analysis. In this setting it is natural to ask if resident in the numbers that represent a work on a computer (henceforth called the digital representation of the work) lies a numerical or mathematical signature characteristic of the creator of the work, *i.e*., is there perhaps a way to quantify the style of an artist? (Coddington *et al*., 2008, p. 1).

Considerations on how many black pixels are in a grid square or "box-counting" became the technique par excellence of researchers trying to detect authenticity in art painting. Such approach has been increasingly complemented by computational sciences in the last decades: The grid squares containing more black pixels will count more for finding authenticity than those that contain fewer. More generally, box-counting squares represent fractals, each one reflecting a scale of the huge canvas. Droplets fill almost totally almost the paint never generating perfectly straight lines. Interrupted gestures expressly traverse it, in an uncountable discharge of thick and light pouring. Thus fractals, the dimension in Mandelbrot's non Euclidean and innovative geometry of nature, have just begun to play an important role in the authentication of Jackson Pollock's work. In fact, disorder, chaos, fluctuations, curls, and an apparently unstructured blurring offer a perfect field of research for the entropy dimension, an extension of multi-fractal methods that announces a statistics tool for authentication.

During the following years, Taylor continued inquiring on the same subject. The most influential article of this period might be "Authenticating Pollock paintings using fractal geometry", which he wrote with Guzman, Martin, Hall, Micolich, Jonas, Scannell, Fairbanks, and Marlow as coauthors. They argue:

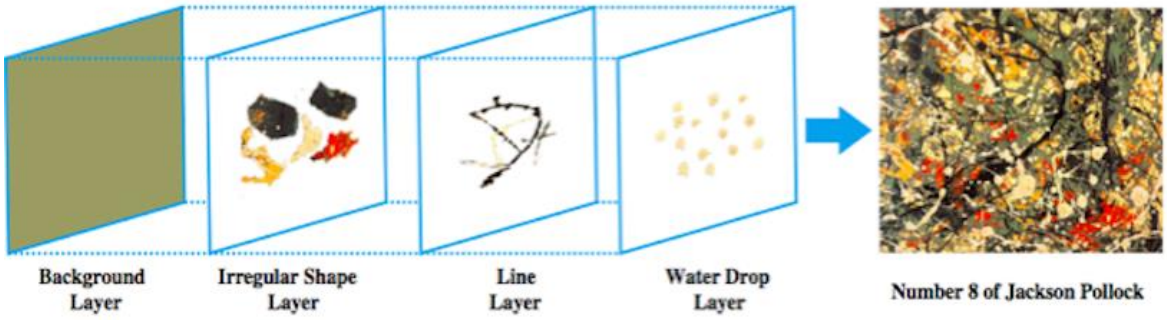
> Jackson Pollock's paintings are currently valued up to US$ 57 M, triggering discussions that attributation procedures featuring subjective visual assessments should be complimented by quantitative scientific procedures. We present a fractal analysis of Pollock's patterns and discuss its potential for authenticity research. (Taylor, Guzman *et al*., 2007, p. 695).

A few years later, Zheng, Nie, Meng, Feng and Zhang gave birth to the Muse of Art that emerged from Design and Processing. They analyze fractal-based algorithms by dividing Pollock's artwork into four layers: From bottom up we find a background layer, an irregular shape layer, a line layer and a water drop layer. The layers are drawn sequentially and independently, forming the desired Pollock style, his signature.

> We have developed a program using Processing [xiv] to generate artworks of the dripping style. The parameters of our program can be randomly generated or tuned by the user, supporting high flexibility and effectiveness. Experimental results show that our layered modeling approach can systematically generate images resembling Pollock's dripping style (2014, p. 591).

They represent the four successive layers in image 4 [xv]:

Image 4.



"The four layers interpreting Pollock's method"

Likewise, a series of complex mathematical specifications on how to measure the fractal dimension follows all previous texts and images. To this point in our approach, we will add a seemingly simple fractal function to reading Pollock's oeuvre, entitled "# 8" (1949), and belonging to the "drip period" of this indeed magnetic artist (Image 5).

In "# 8" Pollock refines his dripping technique. Consciously or not, he works on a fractal dimension. All preceding authors explain his matteric art, where matter, improvised tools and technics, some throwaway artifacts, and stained cloths or everyday leaky containers —the unexpected though— count more than the painting itself, than its potential meaning, excluding interpretation. Is he perpetrating an assault on representation?

Image 5.

"# 8" (1949)

To resume, the four layers *iteration* process designed above by Zheng *et al.* combs all "# 8". In truth, *iteration* traces a pivotal function in chaos theory, and it is quite visible in Mandelbrot and Lorenz classical images of a Dragon (Image 6) and a Butterfly (Image 7) respectively. Thereby we develop an iteration function where each scale resumes with greater intensity the one above:

$$Z_0 = Z^2 + n$$

$$Z_1 = Z_0^2 + n$$

$$Z_2 = Z_1^2 + n$$

$$Z_3 = Z_2^2 + n$$

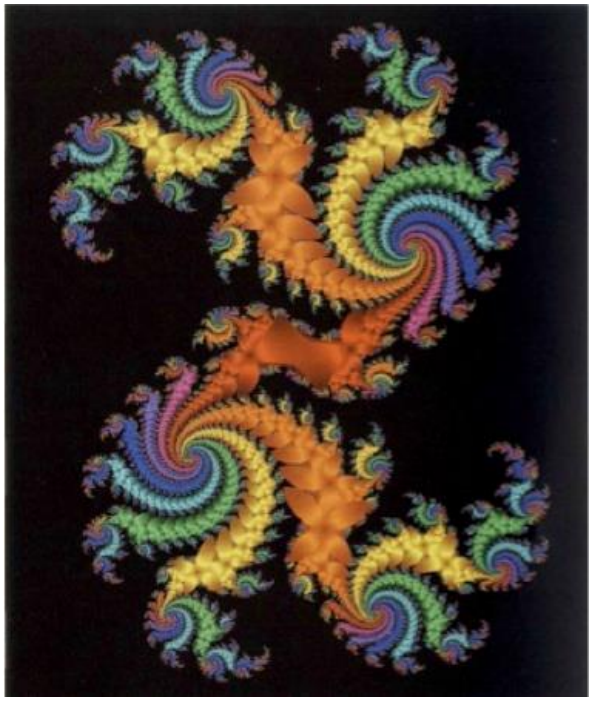
$$Z_4 = Z_3^2 + n$$

$$Z_5 = Z_4^2 + n\ldots$$

In this iteration the list of alphanumeric Z_0, Z_1, Z_2 etc. generated by the looping process is denominated 'orbit' of Z_0. [xvi]

Mandelbrot's iterative function $f(x) = x^2 + n$ deploys the widely set known as the "Mandelbrot Dragon. It exhibits increasing scales, garlanded, swirling, generating a spiral dragon that braves arrogantly a digitized *chef d'oeuvre*.

Image 6.

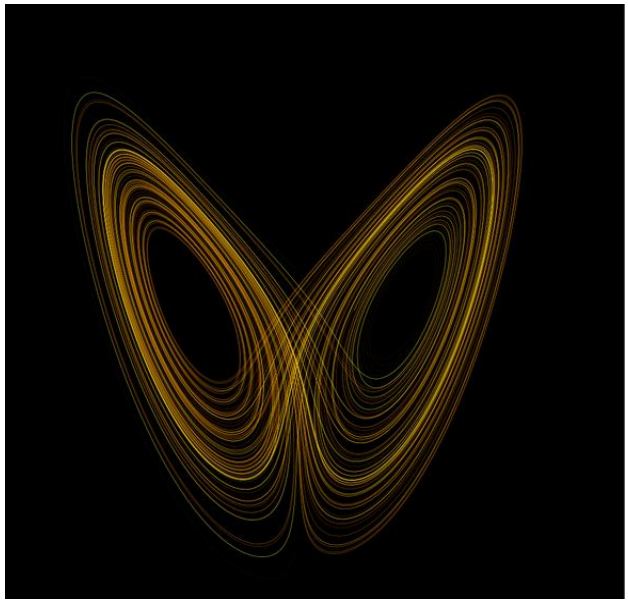


"Mandelbrot Dragon"

The art of pixelating reflects fractals, really assembled with creativity. It could remind us the entangled mangroves in nature with the sort of natural fractalization between branches and branchlets, twigs, roots and rootlets, sprigs, going up to the sky, down to the subaquatic space or entangling with another mangrove tree in a fantastic interlinking above the water, incommensurable, not measurable but dimensional: rhizomes [xvii]. Or, we could notice the evolution of scales in the floating clouds above us, forming another fractal and another fractal again under the blowing wind. When broaching *Lorenz Butterfly*, we spot the scaled fractals turning and whirling around an axial point, never overlapping. Notably, both chaotic images depict abstractions of fractality, but still nature is present there in an apparent disorder and entropy, with life though. Not surprisingly they induce scientists and inspire laymen and artists to keep on wandering.

In "# 8," Pollock could have been frisking chaos as well as simultaneously systematizing it while exploring fluid textures, like we probably do in front of our in silicon web device, like Penelope did when ritually unraveling hers. Briefly, each gesture mirrors our natural and playful interweaving of ideas.

Image 7.



"Lorenz Butterfly"

Thus, the interlink between mangroves and clouds, as well as The "Dragon" and the "Butterfly" above, lead us to observe nature fractals which have surrounded us for millions of years, embracing all senses. Self-similarities [xviii], fractals, and iterations generously illustrate a process of natural evolutionary geometry. We may also observe their diverse abstract formulations in simple mathematical languages as we did above, through metaphors, synthesis, in a marriage between sciences, art, and nature, while echoing Hockney's epigraph above where he intended to remind us our natural unifying condition. So, we will easily detect fractals in next section, but this time in a small flower, honoring indeed all the flowers represented in art and alive in nature.

An eglantine rose: From self-similarities to polar coordinates?

In this third and last section of our review we present the study of a flower, an eglantine rose (Image 8), in the intent of establishing a fractal, self-similar, and iterative relation between "La nuit étoilée", " # 8 " and the beautiful flower, likewise between art and nature.

Three-body-theory, iteration, self-similarity

To enhance the quality and value of van Gogh and Pollock's fractals detected by the already referred researchers, we venture into adding a third body of study, expressly, a lacy petals eglantine rose. In so doing we are mirroring Poincaré three-body-theory, expecting that complexity will emerge. It is worth remembering that the enlightened mathematician, chaos theorist, astronomer, philosopher, and of course, natural bon vivant, calculated the orbits between two astral bodies (the moon and the earth) at the end of the XIX century, and concluded they were mostly invariable. He then surveyed the orbits between three astral bodies (the sun, the moon, and the earth): They changed significantly (Poincaré 2007).

So now we would like to extrapolate this scientific discovery to an everyday, quite handy, and almost trivial phenomenon of discourse. The same kind of complexity is generated when there are two people talking, but the interaction changes, whatever the degree of mutation, when a third personage arrives. Indeed, as we announced before, rhythm, velocity, volume, pronunciation, lexicon, and, absolutely, the ideology and emotions are altered. A whole and almost unperceived innovation takes place when the third interlocutor intervenes.

Now then, the beautiful eglantine rose may simply enlarge the dynamism of fractalization and its complexity when the flower particularities image "La nuit étoilée" and " # 8". In fact, similarities, variations and differences, that is, self-similarities will increase the chaotic dimensions between the three bodies, *i.e.*, both art canvas and the natural art of a flower. New subdivisions, disruptions, complexities and fractalizations, an increment in entropy, might render the interrelation between the three bodies more significant.

Self-similarities and fractals

Poincaré functions exhibit iterations; they are infinite, complex, scaled, and they can be applied to represent nature dynamics. Besides, when looking at Lorenz Butterfly (Image 7), the loops are similar but never exactly the same, thus self-similar. In the Mandelbrot Dragon (Image 6), the spiral racemes are similar, but never exact. Thus self-similarity constitutes a central generative dynamic structure in the geometry of nature. In anyone of their levels, these images show differences and similarities, quite properly named self-similarities in the context of chaos theory. They reproduce the anterior level, telling us again and again that self-similar items will never be exactly similar. They present a certain harmony, a certain kind of geometry, a fractal kind. We might say with all deference that cats, humans, and stars are self-similar inside their group and between the three groups. Along with self-similarity, we recover a part of the line from the anterior line along the recently introduced iteration function. It might be

time now to bring in a very popular anecdote from Mandelbrot's everyday life. His young daughter broke one of those beautiful china dishes with cobalt blue onion flowers interspersed all over their surface, and the pieces on the floor resembled each other indeed, but not exactly, they were self-similar. At the same time there was a consequent and partial iteration of the blue design on each broken piece, as well as a special iteration of the irregularly indented edges. In that moment, a bit before 1977, he invented the word *fractal*, from the Latin form, *frangere*, 'to break' [xix]. In fact, when looking closer, everything around us in the world is fractal, as David Hockney writes in one of the epigraphs above, and we may visualize the reflection of the sunlight at the bottom of the swimming pools he painted all along his Californian life. Although he returned to his native England, he continued to spot fractals in trees, shades, and all around.

Moreover, in the mere core of a plastic, harmonious, neuronal and consonant fractal imagination, the researchers above have connected the phrases *turbulent luminance* and *statistical variance*, through a semantic and complex iteration process, according to the different discursive contexts in which both sequences occur, in mathematics and in art. Yet in the following section we will try to approach extreme self-similarity.

From symmetry and asymmetry to bipolar coordinates

Image 8. "An eglantine rose"

It happens that in our everyday life, we perceive symmetry all around us. It covers an indisputable function in order to reckon perfect similarities when mapping land, oceans, distances or when comparing all sorts of objects and biota. In truth it establishes a most reliable system of representation, and self-evidently an indispensable geometrical tool. Insofar, ideal and abstract Euclidean *symmetry* may be considered as an intentional practice and an abstraction of concrete nature. Nevertheless, from the perspective of chaos theory, two objects are never exactly similar in nature, since there is not such a thing as two or more symmetric coastlines, clouds, rivers, if we consider symmetry in strict sense. It follows that symmetry in nature may be rather a coordination of similarities, as perceived between the leaves of a tree or the petals of a flower [xx].

Therefore when establishing a special kind of self-similarity, of a very low degree indeed, between the opposed petals on each side of the flower heart, we are recurring to the chaos theory *Bipolar Coordinates.* So, when nature is represented whether on canvas, film, silicon or any other support, a broad and open spectrum of varied, relative and scaled *self-similarities* unrolls in front of us [xxi]. For example, the next image represents the opposition between the dotted asymptotic red line, with a perfect, ideal, and conventional symmetry, contrasting with the black line representing a slightly imperfect *symmetry* or *asymmetry*.

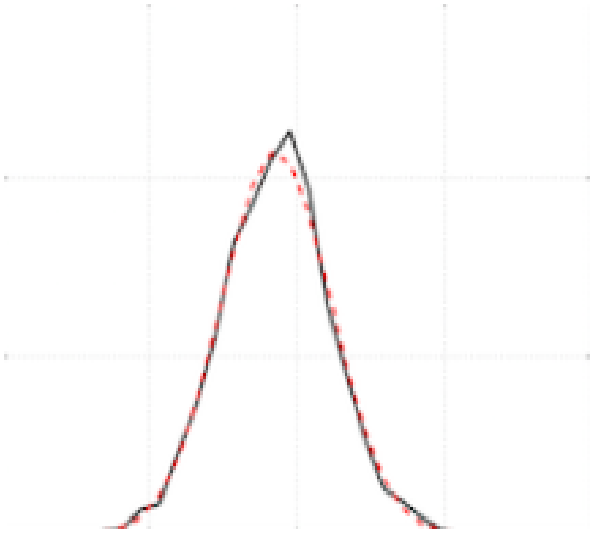
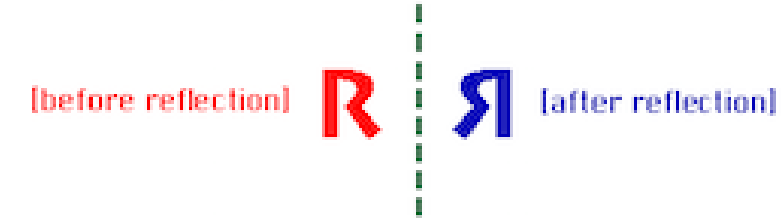
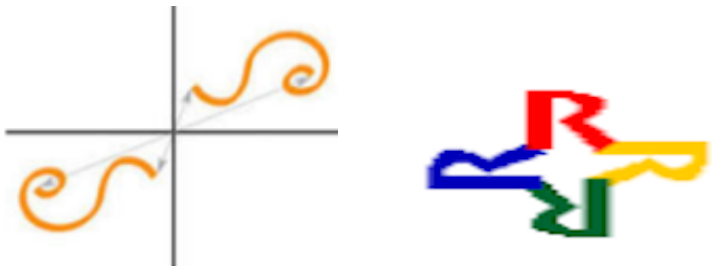


Image 9. Self-similarity represented in a Gaussian curve

Besides, we could imagine three or even an almost infinite number of different types of *symmetry, asymmetry or bipolar coordinates* in the vastly open space of self-similarity, whereas generated by computers or by computers and/or humans. In particular, in the images below there is a representation of the exemplary Euclidian symmetry. It represents the idealized symmetry distributed on both sides of Cartesian coordinated lines. As a result, *symmetry* can be reflectional as in a), punctual as in b) and rotational as in c), between other cases (Image 10).



a) reflectional



b) punctual **c) rotational**

Image 10. Variations of Euclidian symmetry

When unmasking fractals in nature, most chaologists include *bipolar or multipolar coordinates* in their research method. The natural objects under study could be imprecisely described as symmetrical. The eglantine rose petals resemble and mirror each other though, but they are never truly symmetrical, neither when opposed on each side of the corolla nor

when contiguous or close-by. Thus they are described as bipolar or multipolar coordinates in the fractal geometry of nature.

Conclusion

We have chosen three captivating images (Images 3, 5, 8), two from art and one from nature, and we have linked them by means of fractals and by particular semantic meanings they had in common. In so doing, we have intended to study some links between art, mathematics, and nature. In particular, we selected mathematical and computation processing concepts and representations from two interdisciplinary articles to underline fractals can be applied to study painting masterpieces belonging to extremely different periods and genres. Moreover, following Poincaré's three-body-theory, we could show a different degree of qualitative fractality and self-similarity between both masterpieces on the one hand, and a natural beautiful eglantine rose on the other.

During the overall explorative work, we had constantly in mind the Levels of Reality proposed by Basarab Nicolescu in his *Transdisciplinarity Manifesto* (2002). He explains us that when we analyze an object from an upper level of reality we can see and compare the inter- and transdisciplinary objects situated in the level of reality below [xxii]. In this sense he declares the following in the fourth article of the Chart of the *Transdisciplinarity Manifesto*:

> The keystone to transdisciplinarity is the semantic and effective unification of the distinctions between what runs through and what is beyond different disciplines. It presupposes an open-minded rationality, through a fresh look at the relativity of such notions as "definition" and "objectivity". An excess of formalism, rigidity of definitions and a claim to total objectivity, implying the exclusion of the subject, can only have a negative effect (p. xciii).

Thus in our trajectory we assumed that the rich interdisciplinarity, between mathematics and art, established in both Aragon *et al.,* and mainly in Zengh *et al*., was placed in the same level of reality—the level we started our reading and reviewing with.

Interdisciplinarity induced us progressively to position ourselves in a second level of reality, metaphorically speaking, *above* "La nuit étoilée" and "# 8" when considering them in their turn as fractals with their respective self-similarities and iterations. As for this level of reality, we lied the eglantine rose on the same level of reality than both painting masterpieces.

Consequently, the interaction between art, nature, and fractal geometry probably uncovers an unexpected play of associations, similarities, polarities, and differences while seen from a different *Level of reality*. Besides, the fractal exploration moves along from one level of reality to another.

To conclude, chaos theory through *fractal* dimensions, that is in our essay, with the iterative and self-similarity processes, points out insistently that nature is not

measurable, but dimensional. The new theory creates fractal nonlinear dimensions instead of the conventional mathematics and geometrics. Therefore, chaos theory must resort to nonlinear differential equations without bringing perfect, final and complete results as it is literally understood in the classical scientific field. The functions applied in chaology include probabilities and *dissipative structures* when studying nature (Prigogine & Stengers, 1984).

All in all, nature, mathematics and art embody special representations, through their own strategic approaches. They generate their proper codes, principles, theories, methods, words and metaphors as well as scientific values in order to actualize our surrounding realities. Moreover, mathematics as well as art and nature may be fused under the noun *αισθητικός* [xxiii], meaning 'aesthetics', the basic quality of perceiving the world(s) around us through senses and mind. Thus "La nuit étoilée", "# 8", and the eglantine rose display virtues in common, through *fractalization*, *iteration* and *self-similarity*. This new way of grasping the world, probably with a dose of uncertainty, might further the discovery of other links across mathematics, art, and nature, as well as across metaphors, poetry and beauty —closely to Russell, Hockney and Richardson quoted in the above epigraphs. The mathematician scientific reality is generated through a particular jargon; art creates a visual metaphor of reality; and we sense the beauty of nature. These are three sorts of particularly remarkable processes that undoubtedly still require our attention.

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Notes

[i] The word *fractal* was invented by Benoît Mandelbrot (1982). It derives from the Latin verb *frangere*, meaning *to break*, and we will develop it further below.

[ii] We would like to thank D. Myers for reviewing the article as well as J. M. Romero for pointing out various references.

[iii] As exemplary realized by Briggs and Peat (1990), as argued by various authors in Braun & McCarthy's (2000), and as stated in Darbellay (2012).

[iv] Poincaré points out indeed that relations between three astral bodies become more and more complex in the course of time than between two of them.

[v] A good example of the use of the adjective *turbulent* is in tthe title and all along the book *A turbulent mirror: An illustrated Guide to Chaos Theory and the Science of Wholeness* (Briggs & Peat 1990), a creative fusion between chaology aspects and the well known novel *Alice in Wonderland*.

[vi] A *sema* is the minimum unit of linguistic semantic content.

[vii] That goes without saying, that language may transcend interlocutors, users, cultures, societies, ethnic groups, generations, genders, frontiers, and so on, just because its richness grows through its unending and natural life, mobility, use, and infinite quality of adaptation to context as well as to semantic versatility. Thus, language exists through its unending evolutions, inside a continuously growing transculturalization, trans-socialization, transmediatization, and even, from an Asimovian like view, transplanetization. Obviously, language always escapes from fixity, becoming more and more anew, located in the human home of impermanence and creativity, yet being simultaneously systematized by its own oncoming norms, rules, structures, and laws that are transmitted between generations over the course of time.

[viii] We should just signal that since decades the issue on scientific *vs.* not scientific on one side and objectivity *vs.* subjectivity on the other side has concerned most fields of research.

[ix] Occidental mythologies do the same. Besides, etymology could be quite suggestive: Nature derives from latin *natura*, and from *natum*, meaning 'born naked' (Gaffiot 1934).

[x] We bring back for a moment the word *variation* we usually use in everyday life contexts, and which mirrors, but never exactly, the word *variance* in the context of physics.

[xi] *Rehiletes* are Mexican folklore toys resembling pinwheels.

[xii] As a creative medium of expression, matteric art brings into play quite different materials from the ones traditionally used in art.

[xiii] It is pertinent to point out that a year later Taylor's Masters Thesis on *Art Theory, Nature, Chaos and Fractals* is published by the University of New South Wales.

[xiv] A program generated by Reas, C., and Fry, B. (2007).

[xv] We ought to imagine that the empty background in the second, third and fourth layers show more clearly the digital process. We should easily deduce that Pollock always started by splashing usually white or black paint all over the canvas and then he would proceed to add the motifs.

[xvi] We could freely translate the series of equations to a quite common language: Z_0 would be the same person who is submitted to the same process of transformation and that process of transformation gives as a result a new person Z_{01} under the iteration $Z^2 + C$ etc. In this respect, we would like to thank again our

colleague Miguel Ángel Sámano (Universidad Autónoma Metropolitana Azcapozalco (UAM-A), who applies mathematics to social sciences, to have produced this example of everyday life to explain the iterative series (PC, 2006).

[xvii] The figure of rhizomes brings us to Deleuze and Guattari rhetoric, social,political, and philosophical image *mille plateaux* (1980).

(1980). They masterfully associate all sorts of figures, for example on materials in a patchwork, of social formations, bands, of political models in a sort of fractalic way; definitively they bring about non-linear interpretations of world realities and phenomena, as complexity and chaos theory intrinsically do.

[xviii] From chaos theory we may observe easily *self-similarity*, notably from the concept *fractal* (V. footnote 1). When any item is broken in fractals, the broken pieces present some similarities and some differences, sometimes even irregular resemblances, when compared to the original piece or to the rest of the broken ones.

Furthermore, the broken objects remind us life around. In fact, resemblances, similarities, differences, variations, diversities, changes, and nuances surround us over the infinite and open layers and spaces, in our Natural world. We should probably add that the extended fractal perspective considers humans, social groups, and cultures as included in nature.

[xix] . V. endnote 1.

[xx] For example, a similar description could be extrapolated into the sources of general linguistics. In the beginning of last century, Ferdinand de Saussure compares language with a coin. On one side, there is an abstract phonological, morphological, syntactic, and lexical system, which he calls *"*langue", referring to the solid and ideal structure and system of language. On the other side of the coin, we find "parole", all the natural and social variants we produce in our enunciations. Needless to say, the prestigious linguist announced to his students in his course of general linguistics that he was not going to embark in the study of la "parole" yet (1995). Of course, he figured that unending masses of linguistic variants and norms due to dialects, chronological factors and individual concrete enunciations were to be studied _as it has happened since then in the different scientific branches of linguistics. Nowadays, there is evidence that language leaves in a continuous process of change, re-creating itself.

[xxi] As it happened above between the scaled spirals of Mandelbrot's Dragon and Lorenz Butterfly (Images 6 and 7).

[xxii] Between the terms upper and below there is only a spatial hierarchy of representation, and not a superior or inferior value.

[xxiii] Bally. J. (1950). "Qui a le pouvoir de sentir ou de comprendre", Platon. Timée.67a; and Aristote. 1,7,12. Butterfly "Who has the power to feel and to understand" [T. RL]'.