

BIFURCATIONS, CHAOS, AND FRACTAL OBJECTS IN BORGES'
"GARDEN OF FORKING PATHS" AND OTHER WRITINGS



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The mathematical theory of bifurcation originated in the seminal work of Henri Poincaré on systems of non-linear differential equations. The term bifurcation was coined by Poincaré to designate the emergence of several solutions from a given solution. Whenever the solution to an equation, or system of equations, changes qualitatively at a fixed value of a parameter, called a critical value, the phenomenon is called a bifurcation. The point in the parameter space where such an event occurs is defined a bifurcation point. From a bifurcation point several stable or unstable solution branches emerge. Successive bifurcations lead to an irregular and unpredictable time evolution of deterministic nonlinear systems, which is designated chaos. The unique character of chaotic dynamics is their sensitivity to initial conditions as described by Poincaré:

"It may happen that small differences in the initial conditions produce very great ones in the final phenomena. A small error in the former will produce an enormous error in the latter. Prediction becomes impossible, and we have the fortuitous phenomenon" (397).

If prediction becomes impossible, it is evident that a chaotic system can resemble a stochastic system (a system subject to random external forces). However, the source of the irregularity is quite different. For chaos, the irregularity is part of the intrinsic dynamics of the system, rather than unpredictable outside influences. Chaos enables determinism and unpredictability to coexist in the same system. Moreover, surprisingly, a very well defined universal route, which leads from order to chaos, was discovered by Mitchell Feigenbaum. There are abrupt qualitative changes: ordered successive bifurcations, which mark a universally ordered transition from order to chaos: Feigenbaum's universality. The idea of bifurcation is central to contemporary physical theories of irreversible, far-from-equilibrium thermodynamics. The contributions of Prigogine's Brussels School (Prigogine, Prigogine & Stengers) in this regard are of prime importance, showing that bifurcations under far-from-equilibrium conditions constitute the natural mechanism of evolution and of acquisition of complexity.

With a sense of derealization, it may seem strange to the reader that this text has fallen into a journal on literature. What has it to do with literature? What has it to do with Borges? We may be reminded by the metaphysicians of Tlön who "Judge that metaphysics is a branch of the literature of fantasy"¹. Borges once claimed that the basic devices of all fantastic literature are only four in number: the work within a work, the contamination of reality by dream, the voyage in time, and the double (Irby xviii).

From the beginning we have already contaminated the fantastic with scientific, mathematical and physical "realities". A world within a world will be unravelled later on when the reader will be introduced to fractal geometry and fractal objects in the writings of Borges. Our voyage in time has already begun and will throw the reader into the first double or, in the 'strange' terminology introduced here in the very beginning, the first bifurcation:

¹ "Juzgan que la metafísica es una rama de la literatura fantástica" (OC 436).

"Naturally my attention was caught by the sentence, *I leave to various future times, but not to all, my garden of forking paths...* was the *chaotic* novel itself. The phrase *to various future times, but not to all* suggested the image of bifurcating in *time* not in *space*. Rereading the whole work confirmed this theory. In all fiction, when a man is faced with alternatives he *chooses* one at the expense of the others... In the almost unfathomable Ts'ui Pen, he chooses-simultaneously-all of them. He thus *creates* various futures, various times which start Others, that will in their turn branch out and bifurcate in other times...In Ts'ui Pen's work, all the possible *solutions* occur, each one being the point of departure for other *bifurcations*...The explanation is obvious. The Garden of Forking Paths is a picture, incomplete yet not false, of the *universe* such as Ts'ui Pen conceived it to be. Differing from *Newton & Schopenhauer*, your ancestor did not think of time as absolute and uniform. He believed in an infinite series of times, in a dizzily growing, ever spreading network of diverging, converging and parallel times...I remember the final words, repeated at the end of each version like a secret command: Thus the heroes fought, with tranquil heart and bloody sword. They were resigned to *killing and dying*"².

"At the phenomenological thermodynamic level, when we go far from equilibrium, the striking new feature is that new dynamical states of matter arise. We may call these states dissipative structures as they present both structure and coherence and their maintenance requires dissipation of energy. Dissipative processes that *destroy* structure at and near equilibrium may *create* these structures when sufficiently far from equilibrium. Under far from equilibrium conditions there could arise an instability and the appearance of new stable *solutions*... mathematically this is the phenomenon of bifurcation of new solutions. The *choice* between the two possibilities will depend on some external factor or perhaps some unique event that will leave a permanent imprint on the system by the selection... The first bifurcation introduces a single *space* or *time* parameter. But this is only the start. There are secondary and higher *bifurcations* that are possible. It is due to this fact that some systems exhibit a *chaotic* behavior...Mitchel Feigenbaum discovered that the approach to chaotic behavior through successive bifurcations has both qualitative and quantitative *universality*. From *Newton* to Maxwell and Einstein time was reduced to a parameter in the dynamical description of the world: irreversibility was only an illusion This position is no longer defensible" (Prigogine "Nonequilibrium" 50-51).

² "Me detuve, como es natural, en la frase: *Dejo a los varios porvenires (no a todos) mi jardín de senderos que se bifurcan...* era la novela *caótica*; la frase *varios porvenires (no a todos)* me sugirió la imagen de la *bifurcación* en la *tiempo*, no en el *espacio*. La relectura general de la obra confirmó esa teoría. En todas las ficciones, cada vez que un hombre se enfrenta con diversas alternativas, *opta* por una y elimina las otras; en la del casi inextricable Ts'ui Pén, *opta- simultáneamente- por todos*. Crea, así, diversos porvenires, diversos tiempos, que también proliferan y se bifurcan... En la obra de Ts'ui

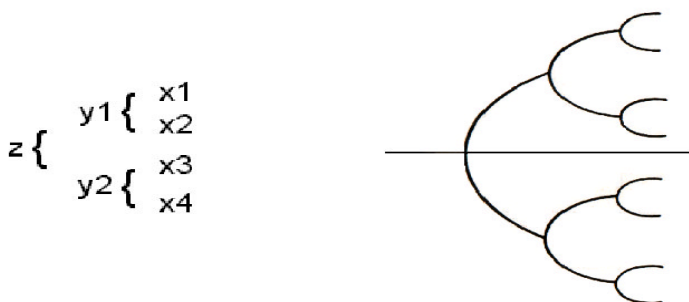


Figure 1

Figure 1 (left) is a schematic diagram of successive bifurcations taken from the above text of Prigogine (51). Where we see just one branch, the long-term behavior of the system tends towards a fixed, homogenous final state. When we see two branches, the system has bifurcated and the long-term behavior of the system is now alternating between two different states. This is called periodic behavior. Since there are two states the period is two. When we see four branches, the system has undergone a second bifurcation and the period has increased to four. More bifurcations beyond period four lead to chaotic, rather than periodic, behavior of the system.

In “An examination of the work of Herbert Quain” Borges suggested that: “Quain regretted the ternary order and predicted that whoever would imitate him would choose a binary arrangement [Figure 1 right] ... and that demiurges and gods would choose an

res, diversos tiempos, que también proliferan y se bifurcan... En la obra de Ts'ui Pên, todos los *desenlaces* ocurren; cada uno es el punto de partida de otras *bifurcaciones*” (OC 477-478). “La explicación es obvia: El jardín de senderos que se bifurcan es una imagen incompleta, pero no falsa, del *universo* tal como lo concebía Ts'ui Pên. A diferencia de *Newton* y de *Schopenhauer*, su antepasado no creía en un tiempo uniforme, absoluto. Creía en infinitas series de tiempos, en una red creciente y vertiginosa de tiempo divergentes, convergentes y paralelos” (OC 479). “Recuerdo las palabras finales, repetidas en cada redacción como un mandamiento secreto: Así combatieron los héroes, tranquilo el admirable corazón, violenta la espada, resignados a *matar* y a *morir*” (OC 478).

infinite scheme: infinite stories, infinitely divided.”³ That binary arrangement is but a typical bifurcation diagram as is obvious from the schematic diagram. The “infinite scheme” unravels chaos.

The similarity between the above texts is quite illuminating. Both themes and phrasings are similar, casting an uncanny feeling of support for the proclamation that “metaphysics is a branch of the literature of fantasy”. It seems that Borges’ fantasy, or rather ours, is governed by naturalistic laws foreseeing the scientific discovery of these laws later on. In this regard we are reminded of Spinoza’s “substance thinking and substance extended are one and the same substance, comprehended now through one attribute, now through the other” (82). Such an approach gives quite a relief, at least to Spinoza: “The chief good is the knowledge of the union existing between the mind and the whole of nature. This, then, is the end for which I strive” (68). Aren’t these passionate strivings for unification between the body and soul, for merging of the self and the object world, the motive forces behind all great universal holistic theories and theorists: Borges’ fantastic theory of man and nature; Prigogine’s irreversible thermodynamic theory; as well as the non-linear, mathematical dynamical theory of Poincaré followed by Chaos theory nowadays?

Both space and time are being treated by the above texts. “When we examine the development of a process over a period of time, we speak in terms used by chaos theory. When we are more interested in the structural forms which a chaotic process leaves in its wake, then we use terminology of fractal geometry, which is really the geometry whose structures are what gives order to chaos” (Peitgen et. al. vii). In “The Garden of Forking Paths” Borges prefers to deal with bifurcations, chaotic aspects involving time, rather than with fractal geometry involving space:

³ “Quain se arrepintió del orden ternario y predijo que los hombres que lo imitaran optarian por el binario... y los demiurgos y los dioses por el infinito: infinitas historias, infinitamente ramificadas” (OC 463)

The Garden of Forking Paths is an enormous riddle, or parable, whose theme is time. The phrase to various futures (not to all) suggested to me the forking in time, not in space.⁴

In *Dreamtigers* and elsewhere we will see that Borges addresses principles of fractal geometry as well.

In the “chaotic novel” in “The Garden of Forking Paths” Borges and us are liberated from the traditional, metaphysical domination by the present and the now. Time is being transformed from:

Then I reflected that everything happens to a man precisely, precisely *now*. Centuries of centuries and only in the present do things happen; countless men in the air, on the face of the earth and the sea, and all that really is happening is happening to me...⁵

into:

the garden of the forking paths was the chaotic novel; the phrase to various futures (not to all) suggested to me the forking in time, not in space... He creates, in this way, diverse futures, diverse times which themselves also proliferate and fork.⁶

The first bifurcation is presented by Borges just in the beginning of the text. After a short but detailed report from A History of the World War mentioning exact pages, dates, and numbers it is noted that it “lacked any special significance”⁷. The first bifurcation creates the “I” in the second paragraph: “...and I hung up the phone. Im-

⁴ “El jardín de senderos que se bifurcan es una enorme adivinanza, o parábola, cuyo tema es el tiempo (OC 479); la frase *varios porvenires (no a todos)* me sugirió la imagen de la bifurcación en el tiempo, no en el espacio” (OC 477)

⁵ “Después reflexioné que todas las cosas le suceden a uno precisamente, precisamente ahora. Siglos de siglos y sólo en el presente ocurren los hechos; innumerables hombres en el aire, en la tierra y el mar, y todo lo que realmente pasa me pasa a mí...” (OC 472-473).

⁶ “El jardín de senderos que se bifurcan era la novela caótica; la frase *varios porvenires (no a todos)* me sugirió la imagen de la bifurcación en el tiempo, no en el espacio...Crea, así, diversos porvenires, diversos tiempos, que también proliferan y se bifurcan” (OC 477-478).

⁷ “...nada significativa, por cierto” (OC 472).

mediately I recollected the voice"⁸. Inherent to creating the I is the creation of a signification system: the symbol, the symbolized and the I as an interpreting subject.

Within the Lacanian account both the subject's entrance into the symbolic and the formation of the unconscious are effected through a single signifying event [a single bifurcation]. This event involves only two signifiers-what Lacan calls the "unary" and the "binary" signifiers. Together they inaugurate a closed system of signification, one which excludes both the phenomenal world and the drives. (Silverman 167).

A dialectic is a bifurcating process in which each of two opposing concepts, creates, informs, preserves, and negates the other, each standing in a dynamic relationship with the other.

The dialectical process moves towards integration, but integration is never complete. Each integration creates a new dialectical opposition and a new dynamic tension [consecutive bifurcations]. In psychoanalysis, the central dialectic is that of Freud's conception of the relationship between the conscious and the unconscious mind. (Ogden 208-209)

In "The Garden of Forking Paths" the first bifurcation forms not only the I but also, necessarily, the unconscious: In Dr. Yu Tsun's deposition "The first two pages are missing"⁹.

Paradoxically, "I-ness" is made possible by the other. Imaginary is the term used by Lacan to designate that order of the subject's experience which is dominated by identification and duality. The subject arrives at an apprehension of both its self and the other- indeed, of its self as other. The "I" in the story is an evasive "I". Who is telling us this story? Captain Little Hart; an agent of Imperial Germany; Dr. Yu Tsun; the descendant of Ts'ui Pên; an illustrious descendant of Ts'ui Pên; Borges? This evasiveness or "deconstruction" of the self in Borges will be further clarified latter on when fractal geometry and objects in Borges writings will be approached.

⁸ "...y colgué el tubo. Inmediatamente después, reconocí la voz." (OC 472).

⁹ "Faltan las dos páginas iniciales" (OC 472).

A central concept inherent to non-linear irreversible processes is the existence of a constant flux of energy through the system, which prohibits the system from returning to an equilibrium position. In this regard one should take the “missing pages”, the unconscious as well as the concept of the lack in Lacan’s writings as a true motive force, which drives the linguistic system far from equilibrium and prevents it from coming to a standstill, to an equilibrium position, to death. The concept of lack appears again and again in Lacan’s writings, figuring centrally at every moment in the development of the subject. Indeed one could say about the Lacanian subject that it is almost entirely defined by lack. Lacan situates the first loss in the history of the subject at the moment of birth. This lack is sexual by definition; it has to do with the impossibility of being physiologically both male and female. Lacan refers to this lack as “real”, by which he indicates that it occurs outside of signification. He tells us that it anticipates further divisions experienced by the subject within signification:

Two lacks overlap here: the first emerges from the central defect around which the dialectic of the avant of the subject to his own being in relation to the Other turns- by the fact that the subject depends on the signifier and that the signifier is first of all in the field of the Other. This lack takes up the other lack, which is the real, earlier lack to be situated at the advent of the living being, that is to say, at sexed reproduction. The real lack is what the living being loses, that part of himself qua living being, in reproducing himself through the way of sex. This lack is real because it relates to something real, namely, that the living being, by being subject to sex, has fallen under the blow of individual death. (204-205)

The first bifurcation, except from the formation of the “I”, establishes time and space, or rather spacing and temporization constituting being along with the present through dynamical dividing, expressed in Derrida’s *differance*:

An interval must separate the present from what it is not in order for the present to be itself, but this interval that constitutes it as present must, by the same token, divide the present in and of itself, thereby also dividing, along with the present, everything that is thought on

the basis of the present, that is, in our metaphysical language, every being, and singularly substance or the subject. In constituting itself, *in dividing itself dynamically*, this interval is what might be called spacing (temporization). And it is this constitution of the present...that I propose to call *archi-writing*, *archi-trace*, or *differance*, which is simultaneously *spacing* and *temporization*. (13)

Derrida's neologism *differance* welds together difference and deferral and thus refers to a configuration of spatial and temporal difference together.

In living systems being far from equilibrium is a temporary state, is a postponement, a deferral. Life always comes to an end; stories always come to an end. The story emerges out of a postponement: "...a planed offensive...had to be postponed..."¹⁰. A postponement, which means and defines life, cannot be merely explained by a "torrential rain"¹¹. A whole story emerges out of this postponement, casting "unsuspected light upon this event"¹². Concerning life and death the prototypic bifurcation in the story, the central metaphorical theme is Albert an individual who symbolizes a city. The death of the man Albert symbolizes the death of the city Albert. Life is a dissipation structure emerging under non-linear far-from-equilibrium conditions through bifurcations. Dissipation structures are destroyed near equilibrium: the symbol, the symbolized and the interpreting subject are destroyed.

It seemed incredible to me that that day without premonitions or symbols should be the one of my inexorable death. In spite of my dead father, in spite of having been a child in a symmetrical garden of Hai Feng, was I -now-going to die?¹³

Life and stories are dissipation structures emerging out of a non-linear postponement characterized by a certain individual selection

¹⁰ "...una ofensiva ...había sido planeada...debió postergarse..." (OC 472).

¹¹ "Las lluvias torrenciales" (OC 472).

¹² "una insospechada luz sobre el caso" (OC 472).

¹³ "Me pareció increíble que ese día sin premoniciones ni símbolos fuera el de mi muerte implacable. A pesar de mi padre muerto, a pesar de haber sido un niño en un simétrico jardín de Hai Feng yo, ahora, iba a morir?" (OC 472).

of a pattern out of a matrix of whole possible bifurcation branches. Such a potential matrix-tree of whole possible bifurcations is presented in the story by the discovery of the chaotic novel.

A third ingredient to Derrida's "differance", beside temporal and spatial interval, is disagreement, or binary opposition. All Western thought is based on the idea of a center, an origin, a truth, an essence. Centers attempt to exclude, ignore, repress or marginalize the other. Deconstruction focuses on the binary oppositions within a text, de-centring the hierarchy and allowing the play of non-stable binary opposites of meaning. Borges allows the play of binary opposites in the chaotic novel:

In all fictional works, each time a man is confronted with several alternatives, he *chooses one and eliminates the others*; in the fiction of Ts'ui Pên, he *chooses, simultaneously, all of them*. He creates, in this way, diverse futures, diverse times, which themselves also proliferate and fork. Here, then, is the explanation of the novel's contradictions.¹⁴

The matrix-tree of paired bifurcations presented in the story by the discovery of the chaotic novel, can be regarded as a free play of a series of paired binary oppositions.

It is not only as another metaphor that we would like the reader to accept our bifurcating presentation of Prigogine and Borges, but as metonymy. Both Borges and Prigogine are parts of a whole. To understand it from the topological viewpoint allows us to introduce another concept of the fractal geometry of nature. Fractal is a word invented by Mandelbrot to bring together under one heading a large class of objects that have played an historical role in the development of pure mathematics. Since early in this century, mathematicians have dealt with pathological sets that are associated with a non-integral, fractional dimension. Such sets have been called fractals. *Fractal* is a word and concept invented by Benoit Mandelbrot:

¹⁴ "En todas las ficciones, cada vez que un hombre se enfrenta con diversas alternativas, *opta por una, elimina las otras*; en la del casi inextricable Ts'ui Pên, *opta, simultáneamente, por todas*. Crea, así, diversos porvenires, diversos tiempos, que también proliferan y se bifurcan. De ahí las contradicciones de la novela" (OC 478).

I coined *fractal* from the Latin adjective *fractus*. The corresponding Latin verb *frangere* means, "to break", to create irregular fragments. It is therefore sensible-and how appropriate for our needs!-that, in addition to "fragmented" (as in *fraction* or *refraction*), *fractus* should also mean "irregular", both meanings being preserved in *fragnet*. (4-5)

Our conventional definition known as topological dimension classifies Euclidean shapes as points (dimension 0), lines (dimension 1), surfaces (dimension 2), and solids (dimension 3), with respect to length, area, and volume. By definition, their dimension must be a whole number. The fractal dimension need not be an integer, and quantifies an object's ability to fill the topological space in which it is embedded. This puts fractals in the realm between the Euclidean dimensions; Whereas Euclidean shapes fall into three categories: a line, a surface, or a solid; fractals may lie somewhere in between. The fractal dimension measures the roughness, or space filling ability of an object. In Mandelbrot phrasing:

It's ironic that fractals, many of which were invented (by 19th century mathematicians) as examples of pathological behavior, turn out not to be pathological at all. In fact they are the rule in the universe. Shapes, which are not fractals, are the exception. I love Euclidean geometry, but it is quite clear that it does not give a reasonable presentation of the world. Mountains are not cones, clouds are not spheres, trees are not cylinders, neither does lightning travel in straight line. Almost everything around us is non-Euclidean. (See Garcia F3)

Euclidean definition, with its spheres, cones, right angles, and straight lines, holds a 2000 year monopoly on our meaning of the word geometry. From the time we are small children we are given the false impression that if a phenomenon does not fit within these strict definitions it is not geometric at all. Circles, triangles, rectangles, and lines were fine until we turned to look out the classroom window. We looked beyond the square window pane to the trees, mountains, and clouds outside and we believed that geometry ended there. (Garcia, F3-4)

Though Borges devotes the garden of forking paths to bifurcation in time not in space, to chaotic aspects and not to fractal geometric aspects, the latter appear intuitively almost unnoticeably in the story

by two contrasting ways of looking out of the window. Under the traditional, metaphysical domination by the present and the now when: "everything happens to a man precisely, precisely *now*. Centuries of centuries and only in the present do things happen"¹⁵, when: "countless men in the air, on the face of the earth and the sea, and all that really is happening is happening to me"¹⁶ then: "Through the window I saw the familiar roofs and the cloud-shaded six o'clock sun"¹⁷. The objects seen, or let us say conceived, out of the window are clearly Euclidean: roofs and sun. Fractal appearances like clouds are regarded as a hindrance with regard to the purity of the Euclidean object: "*cloud-shaded* six o'clock sun". The Euclidean world of perfect objects is a world of estrangement and of loneliness to the individual who is separated, who does not belong there, who cannot establish himself as part of a whole as a magnified fragment of a larger fractal object. It will not surprise us that under such conditions one would try to keep "away from the dreaded window"¹⁸.

In contrast to the "countless men in the air, on the face of the earth and the sea"¹⁹, characterizing non-Euclidean scene, his fractal landscape look totally different: "...I remember a few farmers, a woman dressed in mourning, a young boy who was reading with fervor the *Annals of Tacitus*, a wounded and happy soldier"²⁰. Borges looking out of the window to the fractal geometry of nature is radically different from the previous Euclidean view:

Beneath English *trees* I meditated on that lost maze: I imagined it inviolate and perfect at the secret crest of *a mountain*; I imagined it erased by rice fields or beneath the *water*; I imagined it infinite, *no*

¹⁵ "...todas las cosas le suceden a uno precisamente, precisamente *ahora*. Siglos de siglos y sólo en el presente ocurren los hechos" (OC 472).

¹⁶ "innumerables hombres en el aire, en la tierra y el mar, y todo lo que realmente pasa me pasa a mí" (OC 472- 473).

¹⁷ "En la ventana estaban los tejados de siempre y el sol nublado de las seis" (OC 472).

¹⁸ "lejos del temido cristal" (OC 474).

¹⁹ "innumerables hombres en el aire, en la tierra y el mar" (OC 473).

²⁰ "...recuerdo unos labradores, una enlutada, un joven que leía con fervor los *Anales de Tácito*, un soldado herido y feliz" (OC 474).

*longer composed of octagonal kiosks and returning paths, but of rivers and provinces and kingdoms...I thought of a labyrinth of labyrinths, of one sinuously spreading labyrinth that would encompass the past and the future and in some way involve the stars.*²¹

Here the picture is composed of fractal objects: "trees, a mountain, water, rivers etc", while Euclidian geometry is an interference. Euclidian objects are regarded as a hindrance with regard to the beauty of the fractal object: "no longer composed of octagonal kiosks"²². This fractal landscape is noted by Borges to be characteristic of or formed through bifurcations: "The afternoon was intimate, infinite. The road descended and *forked* among the now confused meadows"²³.

In the preface to *Labyrinths*, Andre Maurois writes of Borges:

A great writer who has composed only little essays or short narratives. Yet they suffice for us to call him great because of their wonderful intelligence, their wealth of invention, and their tight, *almost mathematical*, style. (ix)

Indeed we have seen the similarity, almost identity, in Borges and Prigogine ideas and style. We would like to go further to present Borges topological view of the nature of the human world as fractal.

We are transported into a realm where fact and fiction, the real and the unreal, the whole and the part, the highest and the lowest, are complementary aspects of the same continuous being: a realm where "any man is all men", where "all men who repeat a line of Shake-

²¹ "Bajo árboles ingleses medié en ese laberinto perdido: lo imaginé inviolado y perfecto en la cumbre secreta de *una montaña*, lo imaginé borrado por arrozales o debajo del *agua*, lo imaginé infinito, *no ya de quioscos ochavados* y de sendas que vuelven, sino de *ríos* y provincias y reinos... Pensé en un laberinto de laberintos, en un sinuoso laberinto creciente que abarcara el pasado y el porvenir y que implicara de algún modo los astros" (OC 475).

²² "no ya de quioscos ochavados" (OC 475).

²³ "La tarde era íntima, infinita. El camino bajaba y *se bifurcaba*, entre las ya confusas praderas" (OC 475).

spere are William Shakespeare." The world is a book and the book is a world, and both are labyrinthine and enclose enigmas designed to be understood and participated in by man. (Irby xix)

Like Cantor, Koch, Sierpinski, Peano, Mandelbrot and others' most complex and most beautiful fractal objects (Peitgen et al, 1992), beautiful "fractals" with their self similarity and scaling laws are scattered everywhere in Borges writings. Thus in "The Flower of Coleridge" Borges is citing Shelley who

expressed the opinion that all the poems of the past, present, and future were episodes or *fragments of a single* infinite poem, written by all the poets on earth²⁴,

and ending with

One last observation...For many years I thought that the almost infinite world of literature was in one man. That man was Carlyle, he was Johannes Becher, he was Whitman, he was Rafael Cansinos-Assens, he was De Quincey. ²⁵

We will take just a few examples from *Dreamtigers*, which was acknowledged by Borges, as his most personal work:

Sé que la luna o la palabra *luna*
Es una letra que fue creada para
La compleja escritura de esa rara
Cosa que somos, numerosa y una.(OC 820)²⁶

The dream of one man is part of the memory of all. ²⁷

²⁴ "...dictaminó que todos los poemas del pasado, del presente y del porvenir, son episodios o fragmentos de un solo poema infinito, erigido por todos los poetas del orbe" (OC 639).

²⁵ "Una observación última... Durante muchos años, yo creí que la casi infinita literatura estaba en un hombre. Ese hombre fue Carlyle, fue Johannes Becher, fue Whitman, fue Rafael Cansinos-Asséns, fue De Quincey" (OC 641).

²⁶ "I know that the moon or the word moon / Is a letter that was created to share / In the complex scripture of that rare/Thing that we are, both manifold and one".

²⁷ "...el sueño de uno es parte de la memoria de todos" (OC 797).

Destiny takes pleasure in repetition, variants, symmetries...²⁸

In "Argumentum Ornithologicum" Borges comes even closer to the limitations imposed by Euclidian geometry and towards the basin of fractional dimensions:

I close my eyes and see a flock of birds...In this case I saw fewer than ten birds (let's say) and more than one; but I did not see nine, eight, seven, six, five, four, three, or two birds. I saw a number between ten and one, but not nine, eight, seven, six, five, etc. *That number, as a whole number, is inconceivable.*²⁹

To exemplify it even further it is enlightening to introduce, still from *Dreamtigers*, Borges' Parable of the palace:

The text is lost. There are some who contend it consisted of a single line; others say it had but a single word... His composition sank into oblivion because it deserved oblivion and his descendants still seek, nor they will find, the one word that contains the universe.³⁰

We are reminded of the Heideggerian hope ("The Anaximander Fragment"): the quest for the proper word and the unique name:

The relation to what is present that rules in the essence of presenting itself is a unique one, altogether incomparable to any other relation. It belongs to the uniqueness of being itself. Therefore, in order to name the essential nature of being, language would have to find a single word, the unique word. From this we can gather how daring every thoughtful word addressed to Being is. Nevertheless such daring is not impossible, since Being speaks always and everywhere throughout language. (52)

²⁸ "Al destino le agradan las repeticiones, las variantes, las simetrías..." (OC 793).

²⁹ " Cierro los ojos y veo una bandera de pájaros... En tal caso, vi menos de diez pájaros (digamos) y más de uno, pero no vi nueve, ocho, siete, seis, cinco, cuatro, tres o dos pájaros. Vi un número entre diez y uno, que no es nueve, ocho, siete, seis, cinco, etcétera. *Ese número entero es inconcebible...*" (OC 787).

³⁰ "El texto se ha perdido; hay quien entiende que constaba de un verso; otros, de una sola palabra... su composición cayó en el olvido porque merecía el olvido y sus descendientes buscan aún, y no encontrarán, la palabra del universo." (OC 801).

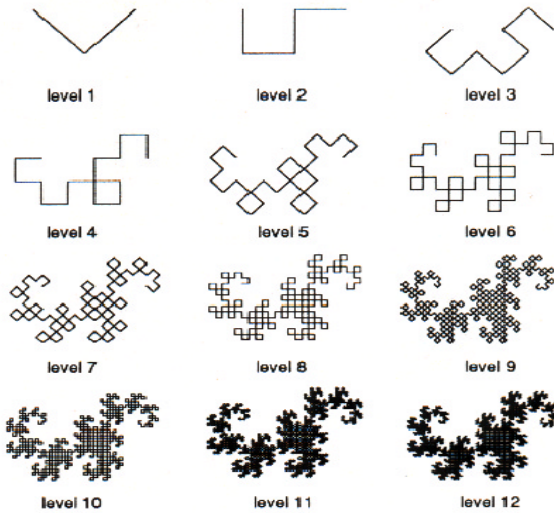


Figure 2

An example from *The Fractal Explorer* (Garcia 91) will be given to illustrate this ability of a meaningless fractal element “a single word” to constitute a meaningful structure. The “dragon curve” (Figure 2) is one of the most basic fractals. A basic shape is produced, generally using straight lines with certain orientation. Each line will in turn be replaced by self-replicated image of the original pattern. This is repeated on each progressing level. As the level of replication continues, a pattern emerges. With only two lines of information a “dragon curve” emerges. Because computer-generated fractal images have similar patterns on many different scales, relatively little code is all that is usually needed to create them. Once written to produce the detail on one scale, much the same software can be reused in a loop to repeat the image on successively larger (or smaller) scales. Thus a remarkably intricate image blossoms from a small, simple piece of software. Thus “a single word, the unique word”, which by itself is insignificant or meaningless through re-

peated self-replicated transformations on successively larger scales "speaks always and everywhere throughout language", throughout language as a fractal object of being and of life.

Scaling features, self-similarities, and fractal topologies are the backbone of Borges writing, particularly in "The Garden of Forking Paths". This story, of bifurcating time and fractal space, starts with descriptions of a grand and holistic world historical event: "History of World War I", and ends with a unique and personal fragment: "He does not know (no one can know) my innumerable contrition and weariness"³¹. These beginning and end, though superficially of totally different perspectives, are, in a way Self-similar, designated "insignificant" by the author: ("Lo demás es irreal, insignificante", OC 480). This insignificance declared by Borges relating to the whole, completed structure, as well as to the smallest part, the personal fragment, emphasizes neither. Again we see that the "I" is deconstructed. The most fundamental elements of the self as a fractal object are meaningless, insignificant, almost formless configurations. What is unraveled, at least in "The Garden of Forking Paths", is the process of morphogenesis of the un-personal whole from the personal fragment. In this regard Borges metaphorical description of the morphogenesis of universal history in "La esfera de Pascal" is illuminating "Perhaps universal history is the history of a few metaphors... Perhaps universal history is the history of the diverse intonation of a few metaphors"³².

Allow us just before the end one last bifurcation (Borges' epilogue, and Poincaré's *Science and Method*) that will keep us alive, that will give us the feeling that we are a part of the world and the world is a part of us:

³¹ "No sabe (nadie puede saber) mi innumerable contrición y cansancio" (OC 480).

³² "Quizá la historia universal es la historia de unas cuantas metáforas... Quizá la historia universal es la historia de la diversa entonación de algunas metáforas" (OC 636-638).

"A man sets himself the task of portraying the world. Through the years he peoples a space with images of provinces, kingdoms, mountains, bays, ships, islands, fish, rooms, instruments, stars, horses, and people. Shortly before his death, he discovers that that patient labyrinth of lines traces the image of his face."³³

"The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were beautiful, it would not be worth knowing and if nature were not worth knowing, life would not be worth living."³⁴

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REFERENCES

- Borges, Jorge Luis. *Obras Completas*. Buenos Aires: Emecé, 1974; English translation by D. Yates & J. Irby. *Labyrinths*. New York: New Directions, 1964; English translation by M. Boyer & H. Morland. *DreamTigers*. Austin: U of Texas Press, 1964; English translation by R. L. C. Simms, Ruth & J. Irby. *Other Inquisitions*. Austin: University of Texas Press, 1964.
- Derrida, Jacques. "La Difference". *Marges de la philosophie*. Paris: Minuit, 1972. English translation by Bass, Alan. "Difference" in *Margins of Philosophy*. Chicago: University of Chicago Press, 1982..
- Feigenbaum Mitchell J. "Quantitative universality for a class of nonlinear transformations". *J. Stat. Phys.* 19 (1978), 25-32.
- Garcia, Linda. *The Fractal Explorer*. Santa Cruz: Dynamic Press, 1991.
- Heidegger, Martin. *Holzwege* (Frankfurt: V. Klostermann, 1957). English translation by Krell, David Farrel and Capuzzi, Frank. *The Anaximander Fragment in Early Greek Thinking*. New York: Harper and Row, 1975.
- Irby, James E. Introduction to *Labyrinths* by Jorge Luis Borges. New York: New Directions, 1964.

³³ "Un hombre se propone la tarea de dibujar el mundo. A lo largo de los años puebla un espacio con imágenes de provincias, de reinos, de montañas, de bahías, de naves, de islas, de peces, de habitaciones, de instrumentos, de astros, de caballos y de personas. Poco antes de morir, descubre que ese paciente laberinto de líneas traza la imagen de su cara" (OC 854)

³⁴ "Le savant n'étudie pas la nature parce que cela est utile; il l'étudie parce qu'il y prend plaisir et il y prend plaisir parce qu'elle est belle. Si la nature n'était pas belle, elle ne vaudrait pas la peine d'être connue, la vie ne vaudrait pas la peine d'être vécue" (Poincaré 22).

- Lacan, Jacques. *Le Séminaire. Livre XI, Les Quatre Concepts Fondamentaux de la Psychanalyse*. Paris: Seuil, 1973. Translated by A. Sheridan. *The Four Fundamental Concepts of Psycho-Analysis*. New York: Norton, 1978.
- Mandelbrot, Benoit B. *The Fractal Geometry of Nature*. New York: Freeman, 1977.
- Maurois, André. Preface to *Labyrinths* by Jorge Luis Borges. New York: New Directions, 1964.
- Ogden, Thomas, H. *Potential Space and the Dialectic Process in The Matrix of the Mind: Objects Relations and the Psychoanalytical Dialogue*. New Jersey: Jason Aronson, 1990.
- Peitgen, Heinz-Otto, Jürgens, Hartmut, Saupe, Dietmar. *Chaos and Fractals: New Frontiers of Science*. Berlin: Springer, 1992.
- Poincaré, Henry. *Science et Méthode*. Paris: Flammarion, 1908. English translation by Halstead, Bruce. *The foundation of science: science and method*. Lancaster: The Science Press, 1946.
- Prigogine, Ilya. *From Being to Becoming*. San Francisco: Freeman, 1980.
- Prigogine, Ilya, Stengers, Isabelle. *Order out of Chaos*. New York: Bantam Books, 1984.
- Prigogine, Ilya. "Nonequilibrium Thermodynamics and Chemical Evolution: An Overview". *Aspects of Chemical Evolution*. Ed. Nicolis Grégoire. New York: John Wiley & Sons, 1984.
- Silverman, Kaja. "The Lacanian Model". *The Subject of Semiotics*. Oxford: Oxford University Press, 1983.
- Spinoza, Benedict de. *Ethics Demonstrated According to the Geometrical Order* (post-humous), 1677. English Translation by Samuel, Shirley. *The Ethics and Selected Letters*. New York: Hackett, 1982.