Tiles for knowledge

For me the two things are inseparable, the love of the beauty of nature
and the desire to explore further the symmetry and subtlety of nature's laws.
Murray Gell-Mann

Introduction

Tile's shape was, for Lindenmayer, the floor for his model of growing. He has borrowed his ideas from Cantor, Kock and Sierpinsky, writes Peitgen (1992:396) and :

"They are designed to capture realistic growth processes".

Tiles are the units upon which, maintaining the same shape and scale invariance, but introducing a little difference, it is possible to show the development of the process of growing. The same happens in the analytic setting. The structure is same, but within every session something new, even very small, appears and modifies the process, even if the analyst is unable, at that specific instant, to detect it.
The same thing happens in nature; a clear example is to look at a tree. It is difficult to say what is changing during a week, but one year late the tree is bigger and wealthy, showing more branches and leaves and fruits, even though all new occurrences seem to be alike.
B. Mandelbrot said (Peitgen et al.,1992:841):

"In the Mandelbrot set, nature (or is it mathematics?) provides us with a powerful visual counterpart of the musical of 'theme and variation': the same shapes are repeated everywhere, yet each repetition is somewhat different. It would have been impossible to discover this property of iteration if we had been reduced to hard calculation...".

The same thing happens in a learning mind. At the beginning it gains a clue and after an understanding. Slowly, it absorbs the hidden meanings and their relationship with conceptual neighbourhood, than assimilation carries out the process and new ideas or experiences become part of knowledge. With these tiles of technical learning, it is possible to embark on the investigation of the ground of correspondence, both clinical and theoretical, between psychoanalysis and non-linearity.

While the correspondence between clinical material and diagrams or graphs, which will be the main purpose of the second part of this book, can easily understand, to be familiar with the similarity between psychoanalysis and non-linearity, or other discipline using comparable tools, it requires an appropriate amount of information. To do this, the most important concepts and devices have been selected from some books, well appreciated in their specific discipline, which use a rigorous methodology.

As expected, I have kept myself away from the use of this concepts, instruments and devices in metaphorical way. This chapter would introduce terms that will be useful for psycho-analysts to understand the basic views of non-linear dynamic theories. During the last decade, many books have been written regarding relationships between psychological disciplines and Chaos and Complexity theories, same very good, some full of misunderstandings and the last ones didn't really help to develop the dialogue between the fields of humanities and the sciences of nature.

Sokal's (1998) crucial criticism on the misuse of scientific terminology by philosophists, psychoanalysts, sociologists, etc., is absolutely correct. The Editorial of Scientific American (February 2001) has reactivated Sokal's criticism underlining that Quantum Physics terminology is easy to use or misuse in our anxious society. Misuse doesn't help to clarify concepts, not to improve knowledge, not to share methodologies; in one word, exploitation closes down and brakes any future development and partnership. Nevertheless, a careful and respectful value of other terminology is just the first stage for understanding. Terminology implies many basic instruments, which procedures make progress in knowledge, followed by a consequential advance in new technological tools. This is a typical example of feedback loop. Many correspondences will appear later.

Glossary

This glossary has been written under the supervision of Prof. Giorgio Mantica, who teaches Physic at the Centre for Non-linear Dynamic Studies at Isumbria University in Como, directed by Prof. Giulio Casati.
The sentences are simple and they try to explain, using, as much as possible, everyday language. Sometime, in order to clarify the content, it has been added a quotation from a book written by an expert in the field. Below, there is the list of these books; I have used the first letter of author or editor, in brackets, to quote them.

Abraham F. D. & Gilgen A. - *Chaos Theory in Psychology* (A).

Berry J. et al. - *The complete A-Z Mathematics* (B).

Gribbin J. - *Q is for quantum. Particle Physics from A to Z* (G).

Kapitaniak T. & Bishop S.R.- *The Illustrated Dictionary of Nonlinear Dynamics and Chaos* (K).

Liebovitch L.S. - *Fractals and Chaos* (L).

Lorenz E..N. - *The Essence of Chaos* (Lo).

Peitgen et al. - *Chaos and Fractal. New Frontier of Science* (P).

Williams G.P. - *Chaos Theory Tamed* (W).

Attractor: is the configuration, or the trace, inside the phase space, of the system's movement. *"A certain combination - a region in the phase space - of possible values of the properties that could be measured for a system", (L)* or *"an equilibrium state to which a dynamical system converges (W)".*
There are different types of attractor*:*

1) fixed-point attractor: the trajectory, which describes the state of a measurable movement in phase space, after a transient *"comes to rest with the passage of time (W)".* The classical example is the damped pendulum.

2) periodic attractor: this is a regular repetition of a set of points to wich the system approaches in the course of time. *"A finite set of points that form a cycle in phase space(W)".*

3) strange attractor: *"Strange means that the attractor is fractal (L)"*; *"An attractor with a fractal structure (Lo)".* The set of points of the measurement of certain combinations of values correspond to a fractal region in the phase space.

algorithmic: Anything that can be coded on a computer, in the broadest sense. Therefore, everything that follows a well-defined rule.

Basin of attraction: The set of initial conditions, in phase space, which eventually evolve into a given attractor.

Bifurcation: to introduce the concept of "bifurcation" I quote 'Chaos and fractals', chapter 11, pg. 585-6:
"One of the great surprises revealed through the studies of the quadratic iterator: n+1 = axn (1-xn), n = 0,1,2,...is that both antagonistic states [order and chaos] can be ruled by a single law. An even bigger surprise was the discovery that there is a very well defined 'route', which leads from one state - order - into the other state - chaos. Furthermore, it was recognized that this route is universal. 'Route' means that there is a series of abrupt qualitative changes - called bifurcations - which mark the transition from order into chaos like a schedule, and 'universal' means that these bifurcations can be found in many natural systems both qualitatively and quantitatively (P)".

Bifurcation is the change of the topological structure of an attractor, as an external parameter reaches a critical point. After this point, two (or more) different attractors may exist; usually, only one of these is stable, and is selected by the dynamics.
Of course, once the bifurcation path is chosen, the dynamical situation has radically changed, and to reverse the process is rather difficult.
One observes sometimes "inverse cascades" of bifurcations, by which the system may return to order from a chaotic situation.

Butterfly effect: See chaos. Exponential sensitivity of the motion on the initial conditions.

CHAOS: is a periodic and irregular motion. It can be defined as deterministic randomness, that means that even if the system is ruled by laws, it is completely equivalent to a random process, as far as predictability is concerned.
The most important physical consequence is the so called **Butterfly effect**, or sensitive dependence on initial conditions.
Usually, chaotic motion is interwoven in the phase space of a system to regions of stability.
Chaos is fullness of information content, and a plethora of possibilities.
Chaos is a general rule in living beings.

Logistic map: The equation **Y = AX (1 - X),** when applied repeatedly, represents the dynamics of a complex system. It is called the logistic map. For instance, it can describe the number of elements of a species in a competing environment: when this "population" is low, it tends to grow; when it is too high, it tends to decrease. The parameter A is a sort of "fertility rate": when A is too small, the logistic curve is low, and the population will eventually go into extinction. When A increases, a stable fixed point is generated, to which the number of individuals of the species is attracted. A further increase of A leads to the splitting of the fixed point into two periodic branches via bifurcation. This process can be continued, leading to periodic points of ever doubling period, until full chaos is reached.

Edge of chaos: *"For a certain range of possible behaviours of strongly non-linear systems, this range surrounding the transition to chaos, the information obtained just at the transition point fully organizes the spectrum of behaviours that these chaotic systems can exhibit"* by M. Feigenbaum (P).

causality: The philosophical doctrine that from the same antecedents follow the same consequences.
The physical requirement that a dynamical theory determines the motion of a system in an unique and precise way.

catastrophe: The change of the topological structure of the locus of the motion of a dynamical system when a parameter is varied.

coevolving: Two systems whose evolutions mutually influence each other.

coherence: The dynamically generated order of many coevolving parts of a complex dynamical system.

complex: The dynamically generated non-trivial structure of a system. This may include spatial complexity:

- the motion is rich of structure when examined in its spatial extension and/or temporal complexity
- the time evolution of the system is chaotic.

complex adaptive system (CAS): A complex system whose structure, and dynamical laws, change by interaction with an environment.

COSTANT (of a system): A feature which does not change over time.

Control: "*If you think that you a are a steamboat and can go up the river, you're kidding yourself. Actually, you're just the captain of a paper boat drifting down the river. If you try to resist, you're not going to go anywhere. On the other hand, if you quietly observe the flow, realizing that you are part of it, realizing that the flow is ever changing and always leading to new complexities, then every so often you can stick an oar into the river and punt yourself from one eddy to the another.*"
(Brian Arthur as quoted by Waldorp, in "Complexity").
"To give your sheep or cow a large, spacious meadow is the way to control him." (S. Suzuki, The sacred balance).
Control replaces the random evolution of a dynamical system by a more desiderable periodic state response, or vice versa.

control parameter: an external parameter, or internal degree of freedom that can be utilized to enforce control.

Deterministic: see causality.

Dimensions: the number of degrees of freedom of a system. They are also called variables.

Dissipative structure: the fact that energy is lost via friction or any other physical means. Equivalently, the loss of phase-space volume during the evolution, and the birth of attractors of zero dimension.

Dynamic: everything which changes over time. As a discipline, it studies:
- the movement of the systems;
- any movements caused by a force or law.

Dynamical system: it is everything we are able to describe, observe or define using a measurement and any conventional alphabet.
Some properties:
1) Any dynamical system can be observed.
2) System's observation requires an outside observer.
3) Observations can be invasive or not invasive.
4) Dynamical systems that can be easily influenced by a perturbation posses sensitive dependence,
5) The state of a system can be described by a string of information.

Therefore, if the system's complexity increases, it also changes both the quantity and quality of the string.

6) Sensitive systems require a complex description.
   For such systems, forecast is difficult, because any perturbation dramatically changes the future course of action, and the symbolic string which follows from it.
7) A system is deterministic when it happens only what is determined to happen; that means: the system follows a series of laws, also unexpressed, and it will continue to behave always in the same manner we expect it to behave.
   - For Laplace: the present is the consequence of the past and the cause of the future.
   - Strictly: the movement can be described in a very simple way.
8) A system is unpredictable because of the presence of unexpected, that is chaotic, movements.

Feedback: the presence of a mechanism by which a step in a certain direction brings consequences to the future state of evolution.

Feedback loop: the competing effects of a feedback mechanism.

Flow: the global motion of phase-space points under evolution.
It determines the trajectories of the system, that is, the values of the dynamical variables over time.

Force field: the deterministic generator of motion in a classical Newtonian system.

Fractals: Geometrical object with non-trivial structure. It shows complex features at any magnification.

FRACTAL GEOMETRY: the study of fractal objects.

Hierarchy: an ordered organization of properties.

Homeo-morphic: of the same structure. It can be applied to topological structure, metric structure, or any other global mathematical property.

Interactive: connected via a dynamical feedback.

Inter-dependence: mutual dynamical relation.

Intervals: ranges in which a variable can vary. They discretize the result of a measurement. An interval can be defined by an item, that is, a definition of the cases, which belong to that interval. Example: major damage to houses is the item that classifies interval 9 of the Mercalli earthquake intensity scale.

Life/individual life: is one of the recursive patterns of nature, because of its evolving processes: birth - grow - reproduction potential - death.
All living systems include these basic features.
As a complex dynamical system life can be measured and visualised as a set of data following the universal laws of nature's fractal geometry, according to which an individual repeats - with small variations - the somatic and psychic characteristics of his ancestors.
Order and Chaos appear in life and can be described by a mathematical model in order to monitor the stable periodic orbit by which we can control an unpredictable stochastic behaviour.

Mathematical model: it is a dynamical system that represents a real world process set of data.

Modelization: the construction of a dynamical system which we believe it may represent a real world process set of data.

Noise: any non-deterministic perturbation of the motion of a dynamical system.

Non-equilibrium: the state of a dynamical system that is evolving.

Non-linear*:* response that isn't directly proportional to a given input.

Non-linear dynamical system: a dynamical system that is governed by non-linear laws.

Non-linearity: there is not any proportionality between the cause of a movement and its consequences.

Open system versus closed system: an open system is perturbed by an other dynamical system, or by noise.

Orbit: the representation (trajectory) in the phase-space of the chronological sequence of a state.

Order: the null-complexity motion of a dynamical system. It can be induced by periodicity, or by any other form of regularity.

Periodic orbit: regularly repeating trajectories.
It is stable when tends to dampen perturbations over time.
"An orbit that exactly repeats its past behaviour after the passage of a fixed interval of time (Lo)".

Poincare' Map: The map that determines the point of next return of a system to a certain region of phase space. When applied to Poincare' sections, that is, low dimensional sub manifolds, effectively helps to visualize the motion of the system.

Prediction: the act of determining the future state of a system.
In chaotic systems:
- it is not possible because any perturbations in the surrounding environment alter the ongoing processes;
- it is difficult because it requires an exponential precision in the knowledge of initial conditions.
- it is unproductive because, to obtain N units of prediction, it requires N units of input information.

Self-organization: the capacity of a system to re-structure itself, so to bring to effect new actions, properties, or interactions leading to a new form of organization. It is typical of coupled systems, where information is continuously transferred from one part to the others.

Phase-space: the collection of variables needed to describe a deterministic evolution.
"A hypothetical space having as many dimensions as the number of variables needed to specify a state of a given dynamical system. The coordinates of a point in phase space are a set of simultaneous values of the variables"(Lo).

Point: *"The representation in phase space of a state of a dynamical system"(Lo). "A state of a system, that is the value of its variables at a given time"(W).*

Plot: A graph, that is, a geometrical representation of the variables of a process, as a function of time, or as a function of their relations.

Process: *"Process theory postulates the priority of the simple and the supremacy of the complex"*, Sabelli, p.107 (A).
It is the evolution, in time, of a deterministic or stochastic system.
From chaos prospective, it is based on simple universal laws, which can be applied to everyday recursive changes, growth and evolution and at any level. It is possible to make both qualitative and quantitative meaningful inferences, by measuring the variables of a multi-dimensional system, especially if the measurement is applied for a long term. Psychoanalysis, for example, is a process of recursive patterns, which repeat themselves for a long time in the same manner, the setting.

Sinergy: l'azione simultanea di più agenti, orientata nello stesso senso, per compiere le stesse funzioni .

STATE SPACE: same as phase space.

QUANTUM THEORY: the dynamical theory of atomic physics.

RANDOM: an event of positive complexity, whether deterministic, or stochastic.

Recursivity: new value is generated from the precedent. Ex: day: morning - afternoon - evening - night. Season: spring - summer - autumn - winter.

Scale invariance: the similarity of the characteristics of a system after change of scale. An item looks like any of a family of objects of different size but similar appearance.

Scaling: the behaviour of the characteristics of a system under a change of the scale of observations, and/or a change of certain parameters. For instance, the length of a curve, as a function of the meter-stick by which it is measured.

Self-similarity: the geometric structure is repeated at different scale or magnification.

Shape: the emergence of a particular configuration in the plot of a deterministic process.

Stochastic: an event occurring irrespectively of the premises. Opposite to deterministic. A pure noise.

SYSTEM: the collection of a phase space, and a deterministic law of evolution.

Transformation: the deterministic law effecting evolution in phase space.

Uncertainty principle: in quantum mechanics, the limitations in the process of measure of conjugate variables.

Universal laws: general properties of the motion in dynamical systems which apply irrespective of the details of the system.

UNPREDICTABILITY versus PREDICTABILITY. The practical and theoretical impossibility of predicting the long-time evolution of a process. Random processes are unpredictable.

Time series measurement: the chronological list of value of any variables.

VARIABLE (of a system): a feature which can change over time.