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A Sociocybernetics Data Analysis Using Causality in Tourism Networks

M. Lloret-Climent, J. Nescolarde-Selva

***Abstract*—**The aim of this paper is to propose a mathematical model to determine invariant sets, set covering, orbits and, in particular, attractors in the set of tourism variables. Analysis was carried out based on a pre-designed algorithm and applying our interpretation of chaos theory developed in the context of General Systems Theory. This article sets out the causal relationships associated with tourist flows in order to enable the formulation of appropriate strategies. Our results can be applied to numerous cases. For example, in the analysis of tourist flows, these findings can be used to determine whether the behaviour of certain groups affects that of other groups and to analyse tourist behaviour in terms of the most relevant variables. Unlike statistical analyses that merely provide information on current data, our method uses orbit analysis to forecast, if attractors are found, the behaviour of tourist variables in the immediate future.

***Keywords*—**Attractor, invariant set, orbits, tourist variables.

I. Introduction

OUR basis for studying tourism and tourist destination management was the General Systems Theory of Ludwig von Bertalanffy [1], [2] who defined a system as "a set of elements standing in interrelation among themselves and with the environment." This means that tourism can be seen as an interrelated and integrated system.

Beni [3] defined the tourism system (SISTUR) as "a set of procedures, ideas and principles that are ordered logically and related to the intention of seeing how tourism operates as a whole." He attempted to conceptualise, describe and define the tourism system, identifying the system's components, its cause-effect relationships, and the rise of controlling and dependent subsystems.

According to General Systems Theory, tourism can be considered an open system, whose elements are environmental relationships, its structural organisation and operational actions.

In this paper, we will focus on the need for accommodation. The environmental relationships subsystem consists of a set of conditions in the environment in which the tourism takes place and which has a specific economic, social, ecological and cultural environment, in constant movement, which interacts with the Tourism System in a multiple and complex relationship.

The structural organisation subsystem consists of the elements of the structure and infrastructure that are essential for tourism to exist. This system includes the state, which defines national or local tourism policy, as well as the other public and private institutions involved in tourism or facilitating it, creating conditions in the community for it to develop.

The client as an element must also be noted. The concept of the client is heavily hierarchised in strategic management models because their inputs (needs, desires, expectations, satisfaction, etc.) optimise the system's configuration and provide feedback with direct involvement in the production-consumption- evaluation process.

In the operating subsystem of tourism, the most important characteristics of tourism products are: intangible, necessary contact between the producer and customer, simultaneous participation of the user in the production process.

These characteristics of tourism are highly complex. Tourists travel to visit another place of which they often have little knowledge. They expect to obtain products and services that satisfy their needs and desires. Consumption of the tourism product requires the involvement of many companies and individuals who do not always have the same quality standards. As a result, a stay in a destination can be ruined by poor service at the airport, or because some of the elements that make up the "package" are not well coordinated.

The current global socio-economic situation is affected by a deep global recession, with serious wealth distribution problems, a depleted natural environment in which natural resources have been drastically destroyed and an economy monopolised by the free market. The common denominator is the lack of systemic, i.e. requisitely holistic, behaviour combined with global impact of the one-sided people and their organisations. Social Responsibility (SR) may be the key factor. The three main pillars of SR are very systemic: (1) holistic approach, (2) interdependence, and (3) assuming responsibility for one's impact on society ([4], [5]).

A socio-economic organisation should analyse the main issues comprehensively, meaning, all the essential subjects and their issues, as well as their interdependence, should be considered, rather than focusing on one issue. Organisations must be aware that efforts to deal with one problem may involve finding a balance with other issues. Particular improvements aimed at a specific topic must not negatively affect other topics or create adverse effects on the life cycle of their products or services in their groups of interest or in the value chain.

ISO 26000 supports both the holistic approach and interdependence indirectly. The same concept can be observed in the seven core subjects of ISO 26000: Accountability, Transparency, Ethical behaviour, Respect for stakeholder interests, Respect for the rule of law, Respect for international

Lloret-Climent, M. and Nescolarde-Selva, J. are with the Department of Applied Mathematics, University of Alicante, Alicante. Spain (e-mail: miguel.lloret@ua.es, josue.selva@ua.es).

norms of behaviour, and Respect for human rights. (ISO, 2010: 10-14). There is a lack of (SR), i.e. of systemic behaviour based on interdependence and a holistic approach, which destroyed slave-driving and feudal societies and became humans' expectations, making room for democracy and a free-market economy. It has become evident from the information that we have today regarding countries' debt worldwide that "the bubble economy" will not be sustained for much longer. SR must replace it.

In the 20th century the definition of sustainability in the 'Brundtland Report' is closely related to its origins (World Commission 1987: 43, [6]): *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* New benefits for the current and coming generations should be provided through innovation: they depend on an essentially holistic approach ([7]).

It is important to bear in mind that the governance and management of innovation depend on the subjective points of view of shareholders and top management, and their ability to adapt to an essentially holistic approach to produce a full set of outcomes (See: [8], [9]). Corporate Social Responsibility (CSR) was first tackled at the European political level in 2000 ([10]): the European Council made "a special appeal to companies' corporate sense of social responsibility regarding best practices on lifelong learning, work organization, equal opportunities, social inclusion and sustainable development." In 2009 the president of the EC, Barroso declared that in times of crisis CSR is central to European policy making (See: [11]): "The crisis resulted, in part at least, from a failure by some businesses to understand their broader ethical responsibilities." In 2011 the EU Commission presented "A renewed EU strategy 2011–14 for CSR" ([5]), stating that "the economic crisis and its social consequences have to some extent damaged consumer confidence and levels of trust in business", which calls for new efforts to promote CSR. In 2011 the EU Commission presented "A renewed EU strategy 2011–14 for CSR" ([5]). With this document, the EU Commission reveals a new definition of CSR as "the responsibility of enterprises for their impacts on society". Furthermore, it states that "to fully meet their CSR, enterprises should have in place a process to integrate social, environmental, ethical and human rights, as well as, consumer concerns into their business operations and a core strategy in close collaboration with their stakeholders, with the aim of maximizing the creation of shared value for their shareholders and for their other stakeholders and society at large; and identifying, preventing and mitigating their possible adverse impacts."

In this article, we will focus on the need for accommodation, in which the tourist companies involved are hotels, campsites, apartments and rural tourism establishments, among others.

According to the authors Lebe and Milfelner [12], "The management of destinations presents new complexities in a time of change and uncertainty [13]. Both consumer behaviour and the supply side in tourism markets have changed. It is no longer possible to simply think of isolated products for naïve clients, but rather it is necessary to consider integral experiences in tourism destinations of excellence... It is therefore vital to improve the working methodology in clusters or tourism destinations".

A more holistic view of tourism is offered by Jafari [14] as "a study of man away from his usual habitat, of the industry which responds to his needs, and of the impacts that both he and the industry have on the host socio-cultural, economic and physical environment."

Causal cognitive maps are graphic tools used to represent concepts and ideas that individuals associate with some specific issue. A causal map is characterized by two ontologies, namely concepts and causal links among them [15]. We illustrate this concept through the Fig. 1.

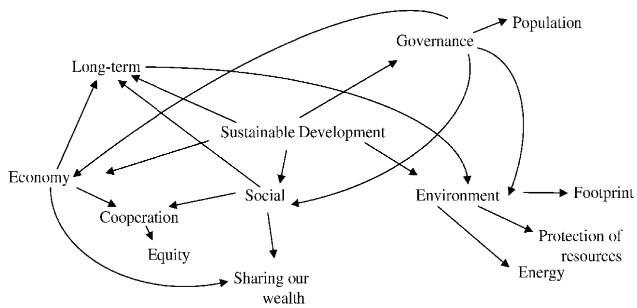

Fig. 1 An example of causal cognitive map

The technique presented here is analogous to the technique of causal cognitive maps novel because it breaks with the usual treatment of the tourism topics and its methodology consists in: our study we need to reduce their complexity in order for the destinations to be manageable and to be able to describe their interdependencies, based on the data published by the Spanish National Statistics Institute (http://www.ine.es/) for overnight stays in various types of hotels, various categories of campsites, apartments and rural tourism establishments. In chronological order, we proceeded as follows:

1) The data were entered in the SPSS software package to obtain the statistical correlations between the overnight stays of various establishments.
2) We know that a correlation between two units is a necessary but insufficient condition for the existence of a causal relationship between the two variables. To ensure that the relationship between the various types of residences is "causal" rather than "coincidental," we used the concept of the conditioning factor, conditional probabilities and categorical variables were used to define the direction of causality between the different types of accommodation: A is a conditioning factor of B if $P(B/A) > P(B/\overline{A})$. This property is used to define the direction of causality between the different types of accommodation.
3) This gave us a directed graph in which the existence of a direction from the i factor to the j factor means that the i factor is a cause of the j factor.

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4) In the last few years a small but steadily growing strand of literature has started to consider tourism systems, and mainly a tourist destination, from a "complex systems science" perspective. Many authors have employed complexity and chaos based approaches to tourism ([16]-[19]). We applied our chaos theory results to this graph to obtain invariant sets, covering between sets, orbits and above all, the attractors in the set. (See appendix)

II. Implementation

We studied fourteen types of accommodation (according with the Normative of the General Secretariat of Tourism in Spain): Five-gold-star hotels, four-gold-star hotels, three-gold-star hotels, two-gold-star hotels, one-gold-star hotels, three- and two-silver-star hotels, one-silver-star hotels, luxury and first class campsites, second class campsites, third class campsites, total hotel establishments, total campsites, tourist apartments, rural tourism accommodation establishments.

For a particular individual, we agree with tourism specialists that "Staying at one type does not cause staying at another", but in this article we talk about the overall behaviour of tourists and for example, an improvement in economic conditions or increased age may indicate a tendency of such behaviour. We should clearly define that this was only our assumptions based on corresponding literature and not the result of our research.

Several authors have used the method of causal maps in the field of tourism, [20], [21] that can be analyzed and understood by computer programs as Ucinet® y Netdraw®, Cossete and Audet [22], Moretti [23]. Garcia et al. [24] analyze the impacts induced by the residential tourism on economic, environmental and social structures of the municipality of Denia on the Costa Blanca of Spain. Merinero and Pulido [25] through the analysis of social networks demonstrate the existence of positive correlation between tourism development of a destination and the existence of dense networks among industry players. Our methodology is a causal map where the various parties involved in tourism responsible for drawing causal maps have been replaced for the method of conditional probabilities to define the causality direction between different types of accommodation in an objective form and network analysis with computer programs as Ucinet® y Netdraw® by a network analysis. We have decided to use this specific methodology, which is original, innovative, daring and, from our point of view, valid to interpret the choice of tourist accommodation and the most appropriate one for the kind of research we are conducting because the software packages mentioned, analyze metrics such as closeness and centrality network with this software only have static measurements of a given network.

To make the data[1] uniform, we chose monthly data for overnight stays in all these various types of establishments from 2001 to 2012, giving us associated data for one hundred and forty-four months.

These data allowed us to obtain the correlation coefficients between each pair of establishments, studied using the SPSS program.

Pairs of establishments with a correlation coefficient greater than or equal to 0.7 were selected, and we used the concept of the conditioning factor to obtain 30 pairs of cause-effect relationships in which the first component was the cause and the second component was the effect, we have chosen a correlation greater than 0.7 because we consider it a coefficient high enough for there to be an interesting network of causes and effects. If we had chosen a correlation less than 0.7 all types of accommodation would be related to each other, so we could not obtain interesting conclusions. In the same way, if the correlation coefficient is greater than 0.7 the network would be too simple so neither would provide information. Most relationships are simple except for some which were bidirectional. Where for example the last relationship (Rural tourism accommodation establishments, one-gold-star hotels), means that people who stay in rural tourism accommodation establishments generally end up sleeping in one-gold-star hotels.

We used the associated graph in the Fig. 2 below to ascertain the intrinsic details of this system. In the graph, the 30 cause-effect relationships obtained where the origin of the arrow represents the cause and effect are represented end. For example the expression: Rural tourism accommodation → one-gold-star hotels means that people who stay in rural tourism accommodation, "generally", by age or by improving their economic status, just overnight in hotels a gold star.

We analysed the sets associated with different types of establishments, determining the coverings between sets, invariant sets, orbits, loops ([26], [27]) and above all the attractors [28]. The concept of orbit determines the zone of influence of the joint behavior of tourists between the different types of accommodation. We used an algorithm developed based on these concepts to facilitate the calculations [29]. The algorithm begins by introducing elements of the system and the direct influences of each element, obtaining an associated matrix where the "l" shows the existence of these direct influences and the "0" indicate their non-existence. Based on this matrix and the positions occupied by the elements of this matrix, the various parameters we require can be calculated. The graphic interface will be a windows environment using the LabWindows CVI compiler developed in C language. In the case of covering between sets, the application should find direct influences of all the variables introduced in the set and included in the string "consult set". Once located, they should be kept in a vector but without repetitions if common direct influences exist and are shown on the screen. In order to detect whether a set is invariant or non-invariant we checked that all the covering vector variables are within the set to be consulted.

[1] The data were obtained from the official website: http://www.ine.es/jaxi/menu.do;jsessionid=CC39F4FEC8335C2D36DA68AC22CAA3F4.jaxi01?type=pcaxis&path=%2Ft11/e162eoh&file=inebase&L=1

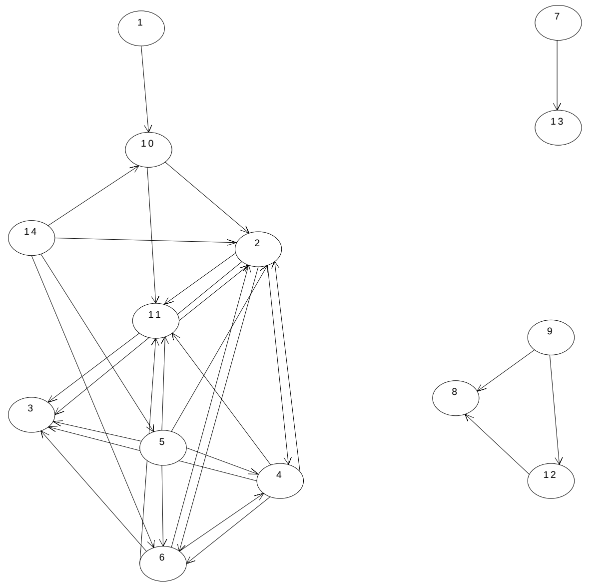

Fig. 2 Associated graph for overnight stays in various types of establishments

If all the variables coincide with those of the set, it will be an invariant set, conversely if this is not the case; it will be a non invariant set. If the orbits of elements and/or sets are to be obtained, the application seeks direct and indirect influences of the sets entered in "consult set". It is possible to introduce one or two sets. In the event that two sets are to be entered, it is necessary to indicate this fact by means of '{...}{...}' so that the application is able to detect that we wish to calculate the orbits of two sets.

III. Results

We make a matrix representation: Five-gold-star hotels (1) four-gold-star hotels (2), three-gold-star hotels (3), gold-two-star hotels (4), one-gold-star hotels (5), three-and two-silver-star hotels (6), one-silver-star hotels (7), luxury and first class Campsites (8), second class Campsites (9), third class Campsites (10) , all hotel establishments (11), Total Campsites (12), tourist apartments (13), rural tourism accommodation establishments(14).

If the (i, j) position is 1, it means that i causes j. If the (i, j) position is a 0 means that i is not the cause of j. Same can add comments on the rows or columns with 0. (See: Table I)

We calculated the orbits of the various types of establishments with the following results:

The establishments {Three-gold-star hotels}, {Luxury and first class campsites} and {Tourist apartments} lack orbits but are included in the orbits of other establishments (their rows in the matrix are zero).

The sets {Luxury and first class campsites}, {Second class campsites} and {Total campsites} form a block that is isolated from the other establishments, as shown in the associated graph in Fig. 2. Likewise, the sets {One silver star hotels} and {Tourist apartments} are another block that is separate from the other establishments.

TABLE I
Matrix Representation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
2	0	0	1	1	0	1	0	0	0	0	1	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	1	1	0	0	1	0	0	0	0	1	0	0	0
5	0	1	1	1	0	1	0	0	0	0	1	0	0	0
6	0	1	1	1	0	0	0	0	0	0	1	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	1	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	1	0	0	0	1	0	0
10	0	1	0	0	0	0	0	0	0	0	1	0	0	0
1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	1	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	1	0	0	1	1	0	0	0	1	0	0	0	0

The other types of establishments interact, as can be seen in the associated graph. A more detailed study of the sets shows us the orbits and enables us to obtain the basin of attraction which is formed by the set:

C={Five-gold-star hotels, four-gold-star hotels, three-gold-star hotels, two-gold-star hotels, one-gold-star hotels, three- and two-silver-star hotels, third class campsites, rural tourism accommodation establishments, total hotel establishments} and the attractor is formed by the intersections of the orbits of the sets located in the basin of attraction. The basis of attraction is the set of variables involved with causes and effects in obtaining the attractor set. The attractor set is a loop and an invariant set satisfying the condition that when the effects reach this set not leave itself but rather remain indefinitely in the set, which in our case is the set:

A= {Four-gold-star hotels, three-gold-star hotels, two-gold-star hotels, three- and two-silver-star hotels, total hotel establishments}

IV. Interpretations and Conclusions

The technique we have set out in this paper is a combination of statistics and chaos theory as, on the one hand, we used correlation coefficients and calculation of probabilities to prepare the data for study, obtaining pairs of cause-effect relationships with their associated graph, and on the other we applied our results in chaos theory to the cause-effect relationships obtained. The authors wanted to use its specific methodology, which is original, innovative, daring and, from our point of view valid to interpret the choice of tourist accommodation.

The most important aspect of our procedure was that, unlike statistical methods that provide information about data at the present time, with the orbital analysis if we find attractors we can anticipate how clients of the various types of establishments behave in the immediate future as the causes chronologically precede their effects, as was observed in this study.

In our case, the invariant set {luxury and first class campsites, second class campsites, total campsites} behaves as an endogamous set in which the elements only relate to each other and maintain their structure and status over time. Interestingly, third class campsites do not interact with any other type of campsite. However, they do interact with the various types of hotel establishments, which in principle is surprising.

The attractor set A= {Four-gold-star hotels, three-gold-star hotels, two-gold-star hotels, three- and two-silver-star hotels, total hotel establishments} represents the goal pursued by tourists staying overnight in the sets located in the basin of attraction.

In this case, four interesting results should be noted:

The first, mentioned above, is the fact that tourists staying overnight in third class campsites end up becoming candidate tourists for establishments located in the attractor set.

The second interesting result is that something similar occurs with tourists who stay in rural tourism accommodation establishments, who are also potential clients for establishments located in the attractor.

The third notable result lies with the hotels in the extreme categories: Five-gold-star hotels and one-gold-star hotels, which even if they are in the basin of attraction are not located in the attractor. It is as if many of the guests at five-gold-star hotels eventually prefer staying in establishments with four stars or less, and as if guests at one-gold-star hotels eventually prefer hotels with two or more gold stars, which implies a more homogeneous behaviour among the clients. This may also be due to the hotels' quality policies.

The final result to note is that the guests at one-silver-star hotels are potential customers for tourist apartments.

We believe that these results can be applied in marketing policies for the various types of institutions - national, regional and local - involved in tourism promotion. The resources available could therefore be optimised considering the medium and long term objectives, rather than the short-term goal. In conclusion, from our point of view it would be preferable to establish advertising campaigns about the sets located in the basin of attraction which are not part of the attractor (Five-gold-star hotels, one-gold-star hotels, third class campsites, rural tourism accommodation establishments), since in this way the establishments located in the attractor set would also benefit.

Tourism is a mainstay in the evolution of the Spanish economy and society, and needs to renew its growth criteria to ensure and maximise its contribution to social wellbeing, shaping the new era of tourism, defined by technological change, environmental responsibility and the demands of the new society.

Among the trends affecting tourism we find environmental trends, with an agenda of political and economic measures concerning commitments to adapt and to reduce climate change and technological developments, which will define not only the means of marketing tourism, but the shaping of the resources themselves.

The ISO 26000 defines seven core subjects of social responsibility: Organizational Governance, Human Rights, Labor Practices, The Environment, Fair Operating Practices, Consumer Issues, Community Involvement and Development and the seven principies of social responsibility: Accountability, Transparency, Ethical behaviour, Respect for stakeholder interests, Respect for the rule of law, Respect for international norms of behaviour, and Respect for human rights which have been considered in this paper. In Spain the Spanish Tourism Horizon 2020 Plan is being implemented by the Spanish Tourism Board. The aim of the plan is that by 2020 the Spanish tourism system will be the most competitive and sustainable, providing maximum social wellbeing. This means the beginning of several activities that the tourism administrations and business people in the sector will develop, committing to the environment, promoting new technologies and considering people as the main asset of the Spanish tourism sector. The central theme of this plan is to improve the sustainability of the Spanish tourism model, optimising benefits per unit of sustainable load and investment capacity, guaranteeing the quality of the natural and cultural environment of each destination, integration, social wellbeing and socio-territorial rebalance.

V. Appendix

The results described below, which are necessary for developing the arguments in this article, have been taken from Lloret et al [30], Esteve and Lloret ([26], [27])

Definition 1: A system-linkage $S=(M,R)$ is the pair formed of a set object M and a set of binary relations R, in such a way that $R\subset P(MxM)=P(M^2)$. In other words, $R=\{(x_1,y_1),(x_2,y_2),\ldots,(x_i,y_i),\ldots\} / (x_i,y_i)\in MxM$.

Definition 2: In a system-linkage $S=(M,R)$ if $(x,y)\in r$ whereby $r\in R$, we shall that x directly influences y.

Definition 3: We shall say that x exerts a indirect influence on y when there exist the elements $x_1, x_2,\ldots, x_n\in M$ and the relations $r_1, r_2,\ldots, r_{n+1}\in R$ where n is a positive integer number such that : $(x,x_1)\in r_1$, $(x,x_2)\in r_2,\ldots, (x_{n-1},x_n)\in r_n$, $(x_n,y)\in r_{n+1}$

Definition 4: In a system-linkage $S=(M,R)$, a set $A\subseteq M$ $A=\{x_i\}_{i=1}^n$ is a loop if its elements satisfy the relationships:

$$(x_1,x_2)\in r_1,(x_2,x_3)\in r_2,\ldots,(x_{n-1},x_n)\in r_{n-1},(x_n,x_1)\in r_n, \text{ where } r_1,r_2,\ldots, r_n\in R.$$

Definition 5: In a system-linkage $S=(M,R)$, the input-output structural function is the function $f_M:M\longrightarrow P(M)$ defined as $\forall x\in M$ $f_M(x)=M_x\in P(M)$, where M_x is a set defined as $M_x=\{y\in M / \exists r\in R:(x,y)\in r\}$.

Following Alseda et al [31] we provide a definition adapted to our environment.

Definition 6: Let $S=(M,R)$ be a system-linkage and let $A,B\in P(M)$, with the structural input-output function f_M. We say that A covers B if $f_M(A)=B$.

In other words, each element in A should directly influence an element in B. From the definition it can be deduced that $B=\cup f_M(x) \quad \forall x\in A$.

Proposition 1: Let $S=(M,R)$ be a system-linkage and let $A,B\in P(M)$ where A is a finite set, with the structural input-output function f_M, such that $A \subseteq B$. Thus, if *A* covers *B*, then we have a loop included in *A*.

We base our definition on the results obtained by Block and Coppel [32] and Alseda et al [31].

Definition 7: Let *S=(M,R)* be a system-linkage and let $A \in P(M)$, with the structural input-output function f_M. We say that *A* is invariant if $f_M(A) \subseteq A$.

Definition 8: Let *S=(M,R)* be a system-linkage and let *x* ∈ *M*. We will call the element in *P(M)* formed of $f_M^n(x) \quad \forall n \in N$ the orbit of *x*, and we will denote it as $Orbf_M(x)$.

In other words, it will include all the direct and indirect influences attained from *x*.

Definition 9: Let *S=(M,R)* be a system-linkage and let *A* ∈ P(M). We will call the element in *P(M)* formed of $f_M^n(x) \quad \forall n \in N, \quad \forall x \in A$ the orbit of *A*, and we will denote it as $Orbf_M(A)$. In other words, it will include all the direct and indirect influences attained from elements in *A*.

By its very nature, each $Orbf_M(x)$ is an invariant set and, moreover, each set covers itself. The orbits are obtained for any set and are defined by the set of all chains of effects, which are based on the elements of the set. The study of the orbits of a system-linkage's elements may sometimes surprise us, given the existence of a subset of the set *M*, which we will call *A*. This is where the orbits of set *M* and one of its subsets will inevitably end.

In this situation we will say that said elements are *attracted* by subset *A*. The formal definition of a system-linkage's attractor follows.

Definition 10: Let *C* be a subset of *M*, so that $A \subset C$. If we consider the sets $A_k = \{ f_M^k(x) \quad \forall x \in C, \forall k \in N \}$, considering that $A_0 = C$, then attractor *A* has the form: $A = \bigcap_{k=0}^{\infty} A_k$.

It can be observed that $A_{k+1} \subset A_k$; that is, the orbits of *C*'s elements are confined, in each iteration, to an ever smaller subset of *M*, the attractor.

Thus, attractor *A* can be considered a subset of *M* to which the orbits of set *C*'s elements are directed; we will call this set *C* the basin of *A*'s attraction.

Note that the attractor will always be a subset of its own basin of attraction. Thus, each element of the attractor will be accessible in each iteration of the input-output structural function f_M from some element of the basin of attraction.

Attractors are zones of attraction that delimit the behaviour of apparently disorganised variables; these areas of attraction make it possible to predict certain related behaviour.

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Miguel Lloret-Climent has a doctorate in Mathematics from the University of Alicante (Spain) and this currently professor of Applied Mathematics in the University of Alicante. He is author and co-author of several papers in journals and proceedings. He is devoted to general research on the Theory of General Systems and Biocybernetics.

Josué-Antonio Nescolarde-Selva graduated in Mathematics from the University of Havana (Cuba) in 1999. He won the award: Gold Title at the University of Havana, Cuba in 1999. He received the PhD degree in Mathematics from the University of Alicante (Spain) in 2010. Since 2002, he has been working in the Department of Applied Mathematics, University of Alicante, Spain. He is author and co-author of several papers in journals and books. He is devoted to research on the Theory of Systems and Belief Systems.