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A new concept of survived complexity

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Abstract

Livable patterns have survived systems with organized structures across multi, fixed and magnified, scales. They try to coexist with their environments by deep topological and morphological evolutions. Each organized complex structure tends to evolve properly to occupy the whole in-between spaces afforded by its surroundings. The more (2D) structures' fractality, the more degree of complexity, occupancy and entropy they have. New parameters of *occupancy (survival) dimensions* (D_S) to estimate the amount of filling specific areas are claimed. Differently from *fractal dimensions* (D_F), these survival dimensions can detect, measure and explain how entropies are distributed locally and globally without the need for a hierarchy of scales. The method depends, basically, on space syntax to analyze (2D) shapes by their *virtual* and *real* structural connections. Commonly survived urban systems have close dimensions of $(D_S \approx 1\text{-}2)$. The resultant dimensions can be measured, testified and used in more reliable comparisons. The new tool of calculating *(2D) systems' entropies* is adopted. However, it requires more investigations and further (3D) estimations in multi-disciplinary fields of knowledge.

Keywords: Survived complexity, space syntax, occupancy dimension, entropies distribution, virtual and real connections

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1. Introduction

Human brains have flexible structures of dynamic configurations in congruent with those of the surroundings. No matter who affects whom, they both try to respond, coexist and survive accordingly by self-reorganizing and compromising between their resultant shapes and underlying behaviors. "Our sensory and cognitive systems have evolved to process only information that is organized" [16]. A visual discrimination of peer shapes across multi levels of magnification (scale-dependence fractalities) is considered to be a crucial way of comparison. Frequently, different structures reveal different fragmentations under zooming. The more fractured structures imply more entropy, complexity and occupancy tendencies. In other words, they have more hot forms. They might be configured differently in some distinct and regular ways, it is claimed. Wondering about having same or similar apparent details is reviewed. A new method provides another mathematical tool to enhance living systems by suitable structural features and configurations. For example, if an object scales with respect to its space, their spatial forms will have the same proportions as a smaller or larger object [15]. Each of which could disclose its instant and accumulated entropies across multi scales.

Structural configuration of a system with *shape-based codes* can reveal their livability. Systems survive only if they maintain an extremely delicate *equilibrium* with their environments by maintaining suitable configurations. But, incorrectly, the conventional methods of urban interventions concentrate rigidly on the largest sizes while ignore the intermediate and small-scale components. Many of the controversies and misunderstandings about the size of cities would be vanished if we deal with different measurement of these size across multi scales [6]. Solutions that can make a great deal of differences focus on small or intermediate sizes' interventions. They are useful in pointing and orienting users' actions to proper scales correctly. It is about positions and dimensions of functional or social aspects. Living urban paths might exist on much deeper levels than we are used to thinking about. Just like ornaments and decorations, they have different entropies and complexities across multi levels of scaling. "One can identify cities from two scales of relationships in the space-time of societies, that of daily interactions and that of evolutionary interdependencies in the longer term" [10]. Recent network connections would absolutely affect the spatial configurations of traditional cities. Modern cities create, mistakenly, dead paths between buildings and

their natural and man-made surroundings. *Traditional survived network connections, that were constructed according to human scale connections, are well structured and almost alive*. New *virtual* (sight) connections can support, compensate or remove great parts of old *real* (exiting) connections from micro to macro scales. Urban spaces and paths might be virtually dens but still spatially porous. Unfortunately, modern architectural and urban approaches try only to replace traditional living structures by contemporary abstract ones. More focusing and hard-working researches on *(virtual-real)* connections investigate the potentialities of their structural configurations and their influence on the spatial geometry of nowadays cities.
The question is about having a new way to detect, visualize, explain and anticipate the behaviors of these instant and accumulated *(virtual-real)* connections. Design principles of differentiation and adaptation are essential to reach living structures [4]. The purpose of this research is to explore other physical properties of (2D) systems according to their structural configurations. It finds a new tool of measurement to estimate their survival dimensions (evolutionary trends). It is concluded that real (existing) systems maintain their potentialities with their surroundings by properly survived complexities.

2. Method

2.1. Survived patterns

Patterns are inherited solutions with dynamic management of changes. They are not machines. Instead, they have bio-cultural adaptations to human needs and functions. They evolve through culture and tradition as systems with sustainable structural configurations. Surviving with the surrounding environments generates useful complexities through feedback from inner evolution. Many man-made systems have specific combinations of *virtual* and *real* structural connections. Their structures tend to respond to outer worlds around and to occupy in-between affordable spaces by such combinations in optimal manners. These spaces would be filled significantly by diffusion and segregation. Their organized complexities require more or less modifications than exist to run frequently. According to both: the hierarchy of their subdivisions and connectivity, survived systems differ from idealized systems that constructed in a modular way.
Urban systems have deep fabricated structures recurring at all levels of magnification. They are very big complex systems that need to be partitioned into small or simple zones for better understanding. The issue is about having any specific apparent qualities across different scales of these subdivisions that might be helpful in determining effective and survived urban network connections. Different urban spaces and buildings are connected together by urban paths (e.g. pedestrians, bicycles, public transports, etc.). It is familiar to have links between particular pathways in relevant to their accessibility and legibility. Urban fabricated structures are normally built from the bottom up at relatively small scales activities of individuals. They must be done as human-scale activities that had been developed through time in a way that imply continual emerging and evolving processes. In the United Kingdom, for example, the concept of survived city is continual processes of dynamical series of steps by which they become more livable and of fast responses to new challenges [18]. Urban planning legislation is sensitive to the uneven urban development experienced by local and national governments. This form of development was determined by occupations and land uses formalized by governmental plans and actions coexisting with informal urban settlements produced by poor people [7]. They make livable patterns in their daily-life worlds, which may be like atoms or molecules, following fairly simple rules of simple initial conditions. The issue is in the patterns not in the parts or origins. In such a case, hierarchical combinations of smaller-scale components and connections with the larger ones are well organized in a coherent whole. Only this kind of partitioning is able to capture the underlying living patterns.
Survived structures deal with enormous amounts of ordered information and relations, that are embodied in *virtual* and *real* connections. They have *equilibrant distributions of connections* that keep them coexistent *visually* and *physically* in balanced tensions. A new mathematical model would be used to estimate and understand these survived patterns by studying their systems' organized complexities.

2.2. A new syntax of spaces

The original premises of space syntax are simple but remarkable. An application of a new syntax of spaces, focusing on topological representations, is presented and adopted. It tries to capture the underlying ordered structures of *living (survived and adaptive) patterns*. Independently of their shapes symbolic meanings, socio-economic conditions or context limitations, the new method provides significant tools to measure spatial changes and to analyze configurative structures. It declares that qualities of structures, especially the spatial configurations of their components, play a central role in how humans' daily-life unfolds one way rather than another. Each structural configuration of a (2D) system embodies specific shapes that reflect equilibrant combinations of *real* and *virtual* connections. The Distributions of these connections are not arbitrary. They tend to balance between *self-preserving* structures by real connections to save entropies and their *natural tendency to extend* by virtual connections to maximize these entropies. Hence, they have other potential entropies represented by a syndrome of *(real-virtual)* connections that are treated differently, as shown in Figure1.

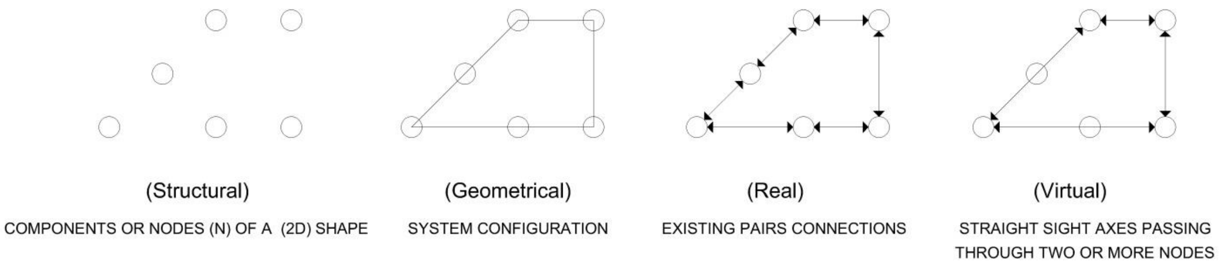


Figure 1. A new (real-virtual) space syntax of a (2D) shape *(Source: The author)*

A developed quantitative method can express, for example, human activities by mimicking their real (physically existed) with their virtual (imaginably extended) urban network connections. From one hand, people usually try to access their destinations with minimum efforts. On the other hand, they prefer to reach without losing their virtual directions. In such cases, it is suggested here to focus on the inter-correlated relationships between real and virtual urban paths. In terms of complex systems theory of, this strong coupling in city trajectories (virtual and real) is almost similar to the evolution processes in biology [14]. Intuitively, visual connections (sight lines) are of further direct extensions than real connections (access lines). Visual connections are necessary for orientation, and for creating a coherent picture of an urban setting. The interdependence between visual connections and paths is highly complex. In other words, they have more entropies of potential conditions.
Cities might have dysfunctional and anti-urban patterns that will keep them destructed to unused pieces of wasted energies. Actually, old survived cities were able to keep their desired complexities and to save their entropies that are related to human-scale and natural environments. Instead of creating anti-survived patterns of isolated individuals in a dead environment, ancestors knew how to use these complexities and how to distribute their entropies efficiently. It is not a fallacy to reason individual spatial cognitions from space syntax because human movement captured by space syntax is accumulated. Because of the common urban dynamics and its rather strong paths dependence, this approach can present a certain prediction for the future of urban systems [9]. The analysis in an urban fabric can express and identify the deeply interwoven spatial form of self-organizing processes with the people's daily life behaviors and choices [3]. Structural components of our recent urban networks can maintain their existence and entropies by (self-rearranging and distributing) to harmonize with our old living cities. Also, new generations of network cities can be evolved. Optimizing human scale subdivisions according to normal daily-life activities would maintain systems' complexities.

2.2.1. Planar shapes' analysis

It is obvious that each (2D) shape has its own complexity which is presented by a specific structural configuration. Regardless of the dominant aesthetic, which influences individual taste, our neurophysiology is tuned to recognize a natural scaling hierarchy [17]. The proposition that its degrees of complexity and how its entropies are distributed could be depicted and estimated. *Survived systems try to maintain their entropies with minimum losses versus a trend to invest their potentialities to maximum extents within their surrounding environment*. Optimal solutions would be achieved always when entropy wastage is minimized instead of its recent exaggerated bad usage [2].
Rationally, each real connection (*r*), which links directly between two adjacent nodes, has a number of nodes equal to $(N_r=2)$. While each virtual connection (*V*), which links between or pass straightforwardly through two or more aligned nodes, has a number of connections equal to $(N_V \geq 2)$. Thus, each connection has real and virtual properties of different quantities. The values of the total lengths of such connections, whether real (L_r) or virtual (L_V), would differ accordingly. Also, each connection of the same type, has specific numbers of nodes *(N)*,

lengths *(L)* and repetitions or frequencies *(Q)*. This classification is the key notion of how to describe, interpret and understand the behavior of different systems by their structural configurations. "Fig. 2" illustrates the new mechanism of classifying and distributing *(real-virtual)* connections.

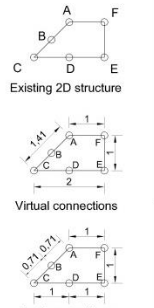
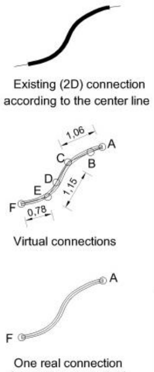
A sample of (2D) structural configuration	Entropy Distribution						
	Connections		Number of nodes (N)	Length of connection (L)	Frequency (Q)	Entropy (NLQ) Sub entropies (E_{Sub})	Σ (NLQ) Resultant entropies $\Sigma(E_{Sub})$
	V: virtual r: real	Similar segments of the same type					
 Existing 2D structure Virtual connections Real connections	V	(A-F) , (F-E)	2	1	2	4	14.23
		(A-B-C)	3	1.41	1	4.23	
		(C-D-E)	3	2	1	6	
	r	(A-F),(F-E),(C-D),(D-E)	2	1	4	8	10.84
		(A-B) , (B-C)	2	0.71	2	2.84	
 Existing (2D) connection according to the center line Virtual connections One real connection (along the center line)	V	(A-B-C)	3	1.06	1	3.18	8.19
		(C-D-E)	3	1.15	1	3.45	
		(E-F)	2	0.78	1	1.56	
	r	(A-F)	2	2.95	1	2.95	5.9

Figure 2. The new space syntax mechanism of (2D) shapes *(Source: The author)*

According to the new syntax of space, each shape has *two* entropies, *real* and *virtual*. They are distributed, as mentioned before, in relevant to *three* factors: *the number of nodes (N), the length of the connections (L) and the number of repetitions (frequencies/ Q).* Estimating the resultant entropies *(E)*, whether real (E_r) or virtual (E_V), is obtained by the summation of sub entropies of connections (E_{Sub}) of the same type. Each sub entropy of every single connection is calculated by multiplying these three previously mentioned factors. Thus:

$$E_{Sub} = N \times L \times Q \quad (1)$$

$$E = \Sigma E_{Sub} \quad (2)$$

$$E_r = \Sigma (N\,L\,Q)_r \quad (3)$$

$$E_V = \Sigma (N\,L\,Q)_V \quad (4)$$

Separately, summation of *real* and *virtual entropies* of every single connection provides a new method to distinguish between (2D) shapes. These comparable entropies are of more accurate calculations. It is natural behaviors to have entropies of specific values and distributions in *fixed* and across *magnified* scales that are responsible for the whole system to be in an equilibrium (steady-state). *According to real and virtual connections, survived systems have ordered and organized complexities (optimal entropies distribution within their surrounding environments)*. "Fig. 3" explains how accretion and reduction of subtle components or connections to common structures affect their apparent degrees of organized complexities and entropies distribution.

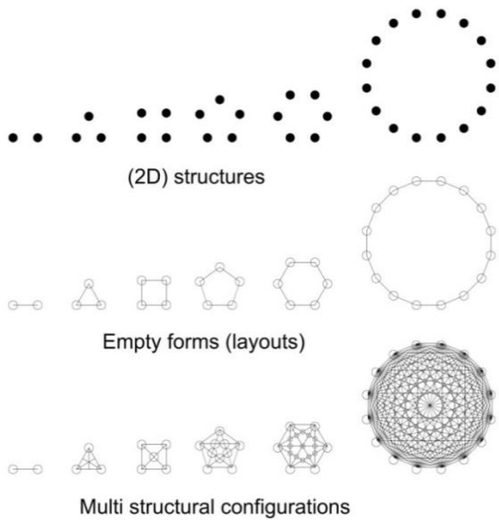


Figure 3. The more bifurcations (components and connections) a structure has, the more complex it can be *(Source: The author)*

2.2.2. The fractal dimension *(D_F)* and the survival dimension *(D_S)*

Chaos theory produced a new fractal geometry that differs from traditional geometry of Euclid. While the latter deals with shapes of integer (non-fractal) dimensions, the former focuses on shapes of fractal (in-between, non-integer) dimensions. *Nothing in nature is of absolute integer dimension.* There are fractal shapes everywhere around. What is appeared to be a line might be dusty detached points that were aligned linearly. Also, a square might be viewed as fractures of segments that could be arranged as what is seemed to be a square.

A fractal dimension (D_F) is a physical characteristic of forms that approximately indicates the amount of filling specific spaces. Estimating of *(D_F)* depends basically on a rational logarithmic relation between changing the scale and changing the number, the length or the area of all fragments and accumulated segments between different consecutive levels of magnification. Fractals claimed that they have comparably similar complex structures at every fixed scaling factor of magnification, like: a cauliflower, a fern leaf, a tree twig, a human lung, etc. They could be found artificially in computer graphics, like Cantor Set, Koch Curve, Sierpinski Carpet etc. Each fractal shows a hierarchy of self-similar patterns at different levels of changing their scales, as a coherent whole. 'Fig. 4" illustrates some common fractals with their dimensions *(D_F)*.

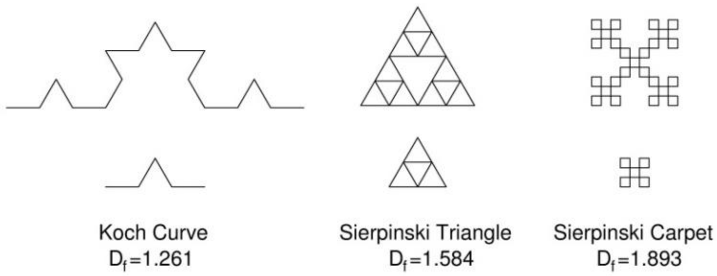


Figure 4. Different fractals with different trends to fill specific areas *(Source: The author)*

The statistical, non-linear and functional relationship between two quantities could be identified by a power law. Simply, magnifying fractals reveals different number of components that obey inverse-power distributions. It means that the number of components in a system is inversely proportional to its scale. Living structures are fractals by perforation or by folding and accretion of their physical elements with suitable configurations and boundaries. Irregularity, porousness and roughness are important properties of these structures. Eliminating living fractalities by strictly interventions would destroy the lower-scales branching.

New aspects of occupancies, as sensitive indicators of filling spaces, can be derived from systems' (2D) structural configurations. In addition to the commonly known fractal dimension, it is claimed here to have *another different fractal dimension (D_S)* to estimate the degrees of systems' complexities according to their occupancy and survive trends. Entropies in various (2D) shapes can be detected, explained and measured by entirely different method of calculations. The issue is to know how these survived complexities are distributed at each fixed and across multi scales of magnification. Obviously, the more irregular, dense and rough objects are the more complex they can be. Similarly, systems with more degrees of complexities have more occupancy (survival) dimensions *(D_S). Horizontally adjacent or vertically layered spots of the same structure might have different values of (D_S) that approach to (D_S=1-2)*. The values increase up to *($D_S \approx 2$)* in overwhelming space-occupation of dense (2D) structural configurations or decrease down to *($D_S \approx 1$)* in empty bounded shapes (layouts).

The big challenge is how to present this new dimension to the audience inside and outside the field of architecture and urban design. *In a survived complex system, locally (fixed) and globally (magnified) structure has well distributed and functioned components and connections that are properly organized in a coherent whole*. By using a new syntax of spaces, it is clear that the intrinsic hierarchies may imply similar responses and behaviors in fixed and across different scales.

2.2.3. Calculating the survival (occupancy) dimensions *(D_S)*

Our common visual sensation of complexity can be estimated, in theoretical mathematics, by testifying artificial patterns. Systems express their structural configurations by calculable degrees of their apparent complexities. A new promising and sensitive parameter, which is similar to the fractal dimension, is presented and adopted here. Simply, it depends on various based-codes factors of (2D) structures. The mutual inter-correlations between *real and virtual connections, that are related locally and globally, are reconsidered differently.* The (scale-dependence) enables us to see more or less similar things in one scale, in addition to far more small things than large ones across all scales to a scaling law of spatial heterogeneity [5]. This new method examines existing systems through fixed and magnified layers of their structural configurations. They have different *virtual* and *real* connections' qualities that are related directly to variant occupancy trends. The number and length of all connections between components, derived from their structural configurations, would affect their complexities. As mentioned earlier, *virtual entropies (E_V) are of more values than real entropies (E_r) because of their natural potentialities*. The survival dimension *(D_S)* indicates a logarithmic proportional relation between these two kinds of entropies. See the calculations in "Fig. 5" and "Fig. 6", which are formulated as:

$$D_S = \log \Sigma E_V / \log \Sigma E_r \qquad (5)$$

$$D_S = \log \Sigma (NLQ)_V / \log \Sigma (NLQ)_r \qquad (6)$$

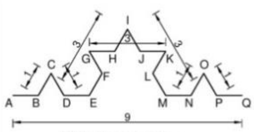
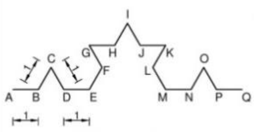
Fractal Dimension (D_F)	Koch Curve structural configurations	Connections: v: virtual r: real	Connections: Similar segments of the same type	(N)	(L)	(Q)	(E_{sub} = NLQ)	$\Sigma(E_{sub})$	Survival Dimension $D_S = \frac{\log E_v}{\log E_r}$
1.261	 Virtual connections	v	(A-B-D-E-M-N-P-O)	8	9	1	72	120	1.381
			(G-H-J-K) , (E-F-H-I) (I-J-L-M)	4	3	3	36		
			(B-C),(C-D),(F-G) (L-K),(N-O),(O-P)	2	1	6	12		
	 Real connections	r	(A-B),(B-C),(C-D) (D-E),(E-F),(F-G) (G-H),(H-I),(I-J) (J-K),(K-L),(L-M) (M-N),(N-O),(O-P) (P-Q)	2	1	16	32	32	

Figure 5. A unique pattern of empty distribution for initial sequent levels of Koch Curve magnifications *(D_S=1.381) (Source: The author)*

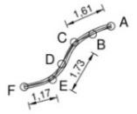
A sample of (2D) irregular connections	Entropy Distribution: Connections — v: virtual r: real	Similar segments of the same type	(N)	(L)	(Q)	(E_{sub} = NLQ)	Σ(E_{sub})	Survival Dimension $D_S = \frac{\log E_v}{\log E_r}$
 Existing (2D) connection with a center line...	v	(A-B-C)	3	1.06	1	3.18	8.19	1.184
		(C-D-E)	3	1.15	1	3.45		
Virtual connections		(E-F)	2	0.78	1	1.56		
 One real connection (along the center line)	r	(A-F)	2	2.95	1	2.95	5.9	

Figure 6: Calculating the survival dimension *(D_S)* of an irregular (2D) path *(Source: The author)*

3. Results and discussions

3.1. Some notes and characteristics of the survival (occupancy) dimensions *(D_S)*

It is claimed that each (2D) shape has its own degree of apparent complexity and its own significant pattern of entropies distribution. The survival dimension *(D_S)* can depict, estimate and explain the tendency of any (2D) structure to occupy (fill) all in-between and affordable areas by its surroundings. So, its value, like the fractal dimension *(D_F)*, approaches a value of *($D_S \approx 2$)* when fractalities, segmentations and bifurcations increase to fill the whole (2D) space, like a fully occupied circle. Also, it would approach *($D_S \approx 1$)* in empty (layouts) and linearly extended (2D) structures.

Each fixed-scale configuration has its own intrinsic survival dimension *(D_S)* regardless of its size. Also, it has different survival dimensions across different levels of magnification. *The survival dimension is more accurate than fractal dimension* because it is sensitive to the existence of porousness and open spaces in addition to the direction of every tiny details of bifurcations. Trying to have a comparison between various *(D_S)* and *(D_F)*, in fixed and magnified structures, is explained in the analyzing of *The Sierpinski Triangle* shown below in "Fig. 7".

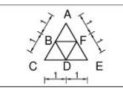
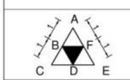
Fractal Dimension (D_F)	Sierpinski Triangle structural configurations	Entropy Distribution: Connections — v: virtual r: real	Similar segments of the same type	(N)	(L)	(Q)	(E_{sub} = NLQ)	Σ(E_{sub})	Survival Dimension $D_S = \frac{\log E_v}{\log E_r}$
1.584		v	(A-B-C),(C-D-E),(A-F-E)	3	2	3	18	24	1.099
			(B-F) , (B-D) , (D-F)	2	1	3	6		
		r	(A-B),(B-C),(C-D),(D-E) (A-F),(F-E),(B-F),(B-D) (D-F)	3	2	3	18	18	
		v	(A-B-C-D-E),(A-L-K-J-I) (E-F-G-H-I)	5	4	3	60	120	1.236
			(B-M-O-H),(L-M-N-F) (D-N-O-J)	4	3	3	36		
			(C-M-K),(C-N-G),(K-O-G)	3	2	3	18		
			(B-L) , (D-F), (J-H)	2	1	3	6		
		r	(A-B),(B-C),(C-D),(D-E) (A-L),(L-K),(K-J),(J-I) (E-F),(F-G),(G-H),(H-I) (B-L),(C-M),(M-K),(D-N) (O-J),(F-N),(M-L),(B-M) (O-H),(C-N),(N-G),(D-F)	2	1	24	48	48	
		v	(A-B-C),(A-F-E),(C-D-E)	3	2	3	18	18	1.163
		r	(A-B) , (B-C) , (A-F) (F-E) , (C-D) , (D-E)	2	1	6	12	12	
		v	(A-B-C-D-E),(A-L-K-J-I) (E-F-G-H-I)	5	4	3	60	60	1.288
		r	(A-B),(B-C),(C-D),(D-E) (A-L),(L-K),(K-J),(J-I) (E-F),(F-G),(G-H),(H-I)	2	1	12	24	24	

Figure 7: Similar configurations with different porosities have different estimated properties according to their survival dimensions *(Source: The author)*

Repetition of exactly self-similar but, magnified, (2D) shapes might be of different entropies. Also, different shapes of similar entropies might have different patterns of distribution regardless of their magnification's factors, see "Fig. 8".

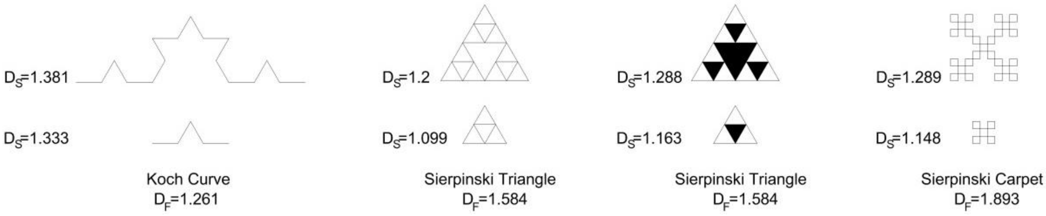


Figure 8. A comparison between the fractal and the survival dimensions for some common (2D) sets *(Source: The author)*

Another comparison, elaborated in "Fig. 9", between the fractal and the survival dimensions of different (2D) shapes, reveals equivalent or approximately similar values for both. Across multi scales (scale-dependence), *these shapes have similar fractal dimensions (D_F) but different survival dimensions (D_S) at each level of magnification*. Compared to the fractal dimensions, changing the direction of different bifurcations can be detected, distinguished and estimated more precisely by measuring their survival dimensions.

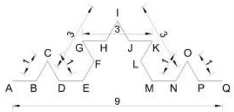
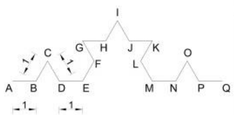
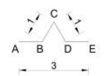
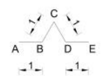
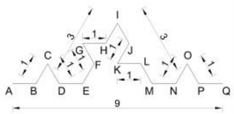
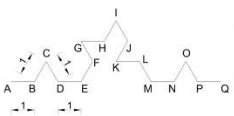
Fractal Dimension (D_F)	Koch Curve structural configurations	Entropy Distribution: Connections – V: virtual r: real	Similar segments of the same type	(N)	(L)	(Q)	(E_{Sub} = NLQ)	$\Sigma(E_{Sub})$	Survival Dimension $D_S = \frac{\log E_v}{\log E_r}$
1.261	 Virtual connections	V	(A-B-D-E-M-N-P-O)	8	9	1	72	120	1.381
			(G-H-J-K) , (E-F-H-I) (I-J-L-M)	4	3	3	36		
			(B-C),(C-D),(F-G) (L-K),(N-O),(O-P)	2	1	6	12		
	 Real connections	r	(A-B),(B-C),(C-D) (D-E),(E-F),(F-G) (G-H),(H-I),(I-J) (J-K),(K-L),(L-M) (M-N),(N-O),(O-P) (P-Q)	2	1	16	32	32	
1.261	 Virtual connections	V	(A-B-D-E)	4	3	1	12	16	1.333
			(B-C) , (C-D)	2	1	2	4		
	 Real connections	r	(B-C),(C-D),(F-G) (L-K),(N-O),(O-P)	2	1	4	8	8	
1.261	 Virtual connections	V	(A-B-D-E-M-N-P-O)	8	9	1	72	112	1.361
			(E-F-H-I) , (I-G-L-M)	4	3	2	24		
			(B-C) , (C-D) , (F-G) (G-H) , (N-O) , (O-P) (G-K) , (K-L)	2	1	8	16		
	 Real connections	r	(A-B),(B-C),(C-D) (D-E),(E-F),(F-G) (G-H),(H-I),(I-J) (J-K),(K-L),(L-M) (M-N),(N-O),(O-P) (P-Q)	2	1	16	32	32	

Figure 9. Different patterns of entropies distribution (different D_S) might be of similar fractal dimensions *(D_F) (Source: The author)*

Systems with similar structures, but different configurations, have approximately similar values of their survival dimensions. They are apparently different, but might imply similar patterns of their entropies distribution. *What are seemed to be irrelated structures, be of similar inner trends and organized complexities*. In addition, composing a (2D) shape, according to a similar initial seed with similar patterns of entropies distribution, might be of a specific range of comparable differentiations, see Figure 10.

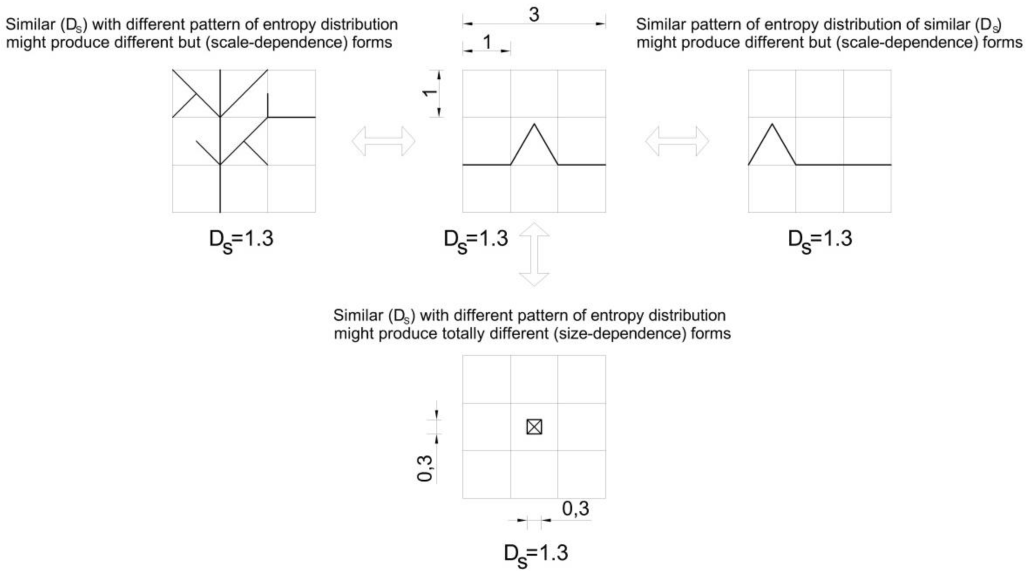


Figure 10. Generation of different (2D) shapes with similar survival or occupancy dimension *(D_S=1.3)* *(Source: The author)*

3.2. Urban patterns

Human patterns respond, coexist and survive in congruent with their environments. Because of the difficulties of having a whole global picture, it would be more realistic to search for these patterns locally according to some reliable and hierarchical levels of magnification (scale-dependence). It is possible to conceive urban complexity in relevant to its universality that sustains the model of scaling ratio at the level of its fundamental principles [12]. The issue depends greatly upon proper human-scale subdivisions. In such cases, the related bottom-up approaches in architectural design and urban planning would have more reliable testimonies to be adopted accordingly.

Urban patterns may disclose and reveal their own secrets. A recognition at a glance of *virtual* and *real* interwoven network connections in existing urban fabrics try to relate them both across different levels of magnification (scale-dependence). *Such bifurcations should end with human-scale fragmentations* of routes' segments that access each individual building unit.

On one hand, micro-scale spatial relationships of urban networks focus on tiny human-scale details. These networks relate, link and reach every individual building and street segment (dwellings' openings and their connections to streets' network). On the other hand, large and macro inhuman-scale subdivisions are deficient to define animate environments. *Lacking of intermediate and small scales connections are of great danger on living systems*. The absence of coordinated components on all scales, including the human-scale levels, is catastrophic. A hierarchy of interrelated networks on different scales, from an expressway down to footpaths, is required. What guarantee the human livability of a city is its small-scale structure, while the large-scale connections facilitate movement on a much higher scale [12].

So, starting with urban paths of human-scale connections on the levels of a neighborhood would be optimal for such approaches, as illustrated in Figure 11. The estimations of survival dimensions *(D_S)* depend mainly upon open areas of the network connections. That explains why the value of *(D_S)* in a modern fabric is more than that of a traditional one. *When open urban paths tend to penetrate, empty and occupy whole areas, the physical (built up) surrounding areas point out lower values of (D_S)*. In such cases, traditional fabrics actually have more *(D_S)* and their entropies distribution, according to their open urban paths, are of more tendencies to respond and coexist properly. The different values of *(D_S)* provide useful and comparable indicators for better survived urban patterns.

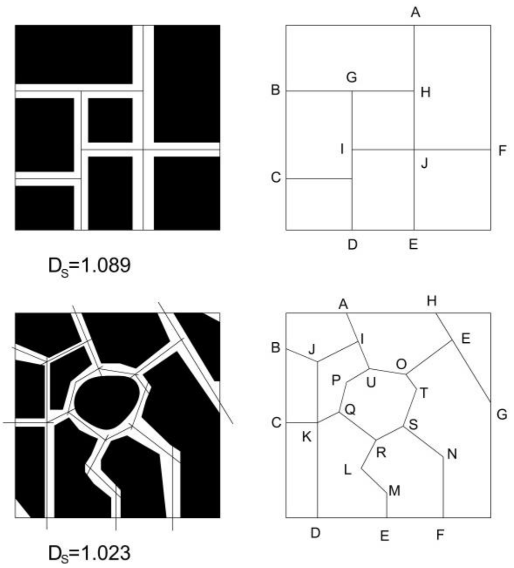


Figure 11. A simple postulated model of grid-iron and irregular patterns illustrates urban network connections and their survival dimensions *(Source: The author)*

Architects and urban planners must learn how to design different, simple and complex, systems with flexible structures that are well organized to survive. At first, they need to erect suitable structures according to initial human-scale functions and activities. A hierarchy of properly organized components and connections across multi-levels of magnification is required to be adopted and developed. It depends basically on the notion that survived structures must coexist with their surrounding's structures by:

1. Appropriate extending to occupy the whole affordable in-between spaces.
2. Self-managing and organizing to run and work properly with them in a coherent whole.
3. Investing all existing physical and visual connections to create optimal distribution of energies as well-organized complexities.
4. Measuring, observing and guiding the resultant survival dimensions *(D_S)* towards desired values of comparable testimonies.

It is important for designers to know how structural configurations of systems can be organized and shaped properly. Systems' energies are exhausted and wasted by disorganized and dysfunctional complexities. Nowadays, it is common to add the wrong sort of complexity to fix minimalist environments. The result would worsen their fitness with social complexity [10]. In other words, for architects, it is recommended to design individual buildings according to human-scale hierarchies. Modern urban planners and architects should accept and catch the concept. They often thought mistakenly that realistic, contextual and functional solutions are adequate to have the needed survived designs. But this is not sufficient alone for human products to live.

Living systems need to organize their complexities by erecting emergent (adaptive) in addition to evolved (survived) structures. The former adaptive complexity is presented in parallel and elaborated elsewhere in a different paper, while the latter survived complexity is explained here. It is a matter of multiplication of symmetries (scale-dependence), differentiation (size-dependence) and organization (adaptive and survived complexity) to have man-made evidences that mimic living structures.

The result offers a mechanism to indicate and calculate the most optimal scale-dependence subdivisions. Human-scale environments guarantee piecemeal urban complexities. They start from the micro urban network levels of the human daily life activities up to macro levels. The complexity will not be random but it is highly suggested when this procedure is followed. *Gaps in scaling where nothing is defined destroy urban coherence*. Real and virtual connections provide similar (but different type) of organized complexities when they are intellectually computed and applied to designs of cities as evolving structures. For cities within space syntax applications, fewest and longest (access and sight) lines on an axial map are adopted according to urban *virtual* and *real* network connections respectively. It explains how these variants with their potential entropies were

distributed. One can notice that this distribution can be found in a variety of physical, biological and human-made phenomena. It links power laws to a fractal logic [8].
Cities can be classified according to their accessibilities by the new method of survival dimensions. These dimensions determine the extent to which cities fill the space that they occupy in terms of their network structures. In modern cities, the demand for housing shifted from the center to the suburban, where the cost per square meter is lower because of the availability of lands, generating sparse suburban zones [13]. It is necessary to know the correct systematic rules under which survived urban networks, are structured. Land use planning tries to organize and control the pattern of urban occupation and expansion to ensure that people's daily-life activities and functions are in continual, harmonic, balanced and sustainable development with the urban regions [1]. The question is about having urban networks with acceptable amounts of complexities similar to the human qualities of survived, natural and traditional urban fabrics. Recently, most countries are experienced by the challenges of increasing urbanization (with more demands for efficient and sustainable urban services) in digital revolution environments which enhance the concept of livable city [19]. Depending upon the works of Boeing [2], "Fig. 12" compares three modern network patterns of (Portland, San Francisco and Irvine) with the traditional Rome according to their survival dimensions.

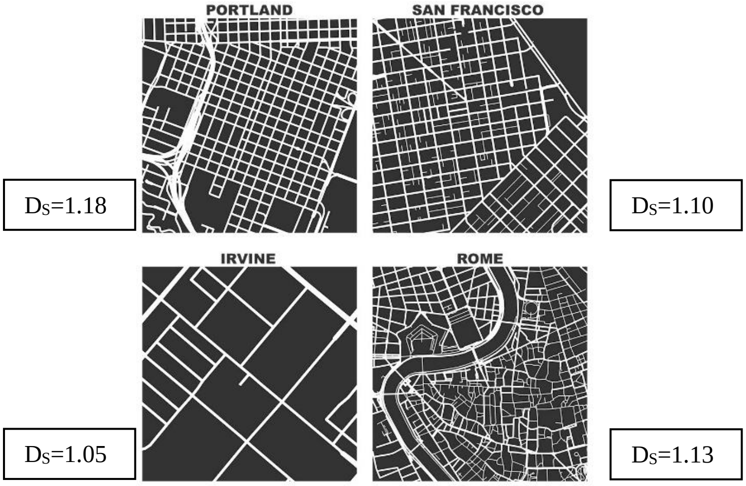


Figure 12. Based on the work of (Boeing, 2017:136), survival dimensions of different existing urban network connections are of comparable evaluations *(Source: The author)*

More reliable quantitative comparisons should depend upon calculating the total *survival dimension (D_S)* of different samples of the same scale. Accordingly, we need to scrutinizingly examine and identify damaged and infected networks by:

1. Estimating their *local occupation* of specific (2D) spaces and bounded areas by calculating their survival dimensions *(D_S)*.
2. Comparing the resultant values with those of commonly known healthy and survived ones.
3. Suggesting a suitable solution either by adding or removing some parts (components and connections) correctly. Specific and acceptable ranges of dimensions could be calculated for proper interventions comparably.

4. Conclusions

Systems differ according to their potential complexities and entropies. They try hardly to respond to different stimuli by properly *keeping and maintaining* their entropies within their surrounding environments. Naturally, they all tend to occupy and fill the whole available and affordable in-between local and limited spaces. Their (2D) structural configurations have more characteristics to be investigated and revealed.
The common and default approach was about asking for self-similar fractality across many scales to have *globally survived systems*. This was the biggest misleading fallacy ever thought and happened. Recently, this shifts towards tracing *local (2D) patterns of similar entropies distribution* with new detecting parameters of *survival dimensions (D_S). Their systems might have inspiring but also deceiving shapes.* These shapes show

reliable indicators of survived structures. Each structure has its own limitations with its surrounding environments. They try to respond, reply and coexist with their neighbors by properly organizing of their complexities. They impose specific patterns of entropy distributions depending upon *virtual* and *real* connections that might be properly matched or severely diverged. Structural configurations could be apparently different but have approximately similar patterns of entropy distributions (equivalent survival dimensions).
A comparison with existing survived patterns provides a specific (limited) range of acceptable and recommended dimensions *(D_S)*. This would guarantee, to somehow, correct decisions with suitable interventions to solve profound problems. Different urban network structures, that are configured according to human-scale subdivisions, are survived. Further investigations for analyzing (3D) survived structures are required to enhance the concept.
The suggestion is to recognize commonly survived and healthy existing (2D) structures by their organized complexities instead of their apparent forms. Environmentally survived patterns are not certainly livable. They need to be supported by parallel adaptive solutions. Adaptive (emergent) processes and survived (evolving) forms feed living complexities to organize themselves and to distribute their entropies properly. Hence, eventually living patterns should be survived and adapted at the same time.

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