Wrangling Stochasticity & Deconstructing Dimensionality: An Illustration of Fractals in Discursive Spaces

Dr. Douglas Rose

Strategic practitioners and analytic methodologists actively involved within cyberspace management, defense, and manipulation require an exceptionally refined mastery of concepts associated with specific approaches in order to effectively parse recommendations, actions, and other related outputs. This implies the presence and value of physical and cognitive dimensionality. Specific to this growing awareness of dimensionality as it relates to data across a myriad of channels and communities resides a need for development of awareness of specific spaces, how they align with parallel instantiations of information due to their shape, and how their temporally-appropriate abductive to deductive span contributes to the development of hypothesis and theory. Guiding any cohort to think in this way requires an understanding of a virtual system of systems and an appreciation of how specific shapes and spaces might represent a comfortably conjoined path within an emergent methodology.

Targeted research regarding threats within the cyberspace domain reveals an enterprise diluted primarily

 doi: 10.18278/gsis.5.2.8

by excessive lexicon development and over-mathematization of semantics by those charging toward adoption of Artificial Intelligence (AI) and machine learning (ML). These observations are the genesis of this piece. Heavy emphasis on the intersection between applied complexity science, existing dimensionality and its reduction, and slices of the laws of thermodynamics pushes this work radically past *a priori* publications mostly confined to a narrow relationship between strictly linear, hierarchical models designed to manipulate massive amounts of data.

The continuation of legacy logic dependent on concrete, almost zero-dimensional approaches and attitudes surrounding the defense of cyberspace does nothing to advance the discipline and execution of analytical activities in support of virtual instantiations on a micro scale. This discussion depends on the assertion that specific instantiations of structure can be abstract in the sense that they are boundaries of a theoretical plane of scientifically supported process and physical existence, and real in the sense of their reliance on hard and complexity science. The self-organizing nature of complex adaptive systems (CAS), intricacies involved with dimensionality reduction techniques, the flexibility of fractal geometry, and specific intersections related to the second law of thermodynamics drive this study toward a designation of a real, virtual assembly. This approach forces adoption of a nonlinear abstract as a staple of any analytic activity that might benefit from temporally based spaces and shapes since there is no model to abide by in all circumstances, only a focus on the thing itself. These are called profiles (Mitchell 2009, 101). This is a delineation of metadata selection, an illustration of the appropriate virtual structure, and an approach to designation of microstates.

One of the standard approaches to complexity science assumes that there are modulators in the system to the *n*th degree, while most observations are only aware of a limited portion at any one time. Variances in meaning, relevance in time, and the ever-expanding volume of information in a virtual domain require concessions that *n*-dimensions are directly relevant (Jacobson 1967). This is mass in an analytic sense, which helps us argue for the presence of dimensionality—however reduced—on the road toward acceptance of its reality.

This is not another attempt to address the broad series of discussions surrounding usefulness and selective applicability represented by both the community and concept of big data. Rather, this is a measured series of distinctions that represent and dissect the intersections between portions of specific concepts in order to demonstrate the rigorous characteristics of certain abstracts, broaden awareness across multiple dimensions of information-based reality, and drive human-oriented, repeatable containerization of situationally-oriented data and information. The resultant output is an assembly of phenomenological, scientific, and philosophical methodologies in support of cyber analysis designed to achieve a natural beginning of an invocation of the

continuing need to demonstrate the fluidity of multi-dimensional, approaches to virtual structure. This means that both the understanding and the metaphysical indeterminacy (Sennet 2012) related to cyberspace are likely underdeveloped. If one considers this hierarchy to be a valid instantiation of an information system, then there also needs to be a concession that the placement of that label within any process and its dependence on time-based dimensionality results in structured representations of relationships. These are fractals.

Cyberspace treats structure as the totality of quantifiable relationships among the components that comprise it (Allen, Stacey, and Bar-Yam 2017), and fractals, when considered inert containers for what might be ascribed to them (Chettipramb 2005), offer several extra-disciplinary precedents when attempting to extract meaning from spatio-temporal transients of events (Sulis 2019). There is no specific assertion of a specific kind of shape that qualifies for the fractal label, as they can be any geometric object, and the concept of shape does not determine behavior of all parts of a system. Fractals' ability to help us see the world qualitatively (Chettipramb 2005), given their linkage between genesis and nonlinear optimization during any analytical effort (Fellman 2014), naturally results in a profile as an output. The resultant profile—that which embodies data, not a model—elies on nonlinear aspects that are neither learning nor analysis on their own as much as they are associates of those processes. Approaching the formation of a center in this way requires a realization that an entity dependent on a hierarchical manner shrinks any disassociation between nonlinear dimensionality reduction and complexity.

Borrowing directly from physics, various discussions about spaces take several forms in the existing literature. Allowing such a construction within a chosen space, in particular the loosest portion of space that is cyberspace, merits mention of the notion of discursive spaces given their dynamic representations of qualitative dimensions and data (Maciag 2018). The discursive space is not a separate system, but one that emerges from one in order to allow gathering of specific knowledge about it. These are of value because they allow for emergent phenomena due to their supervenience and reliance on organic complexity. Thus, they make it possible to visualize parallel coordinates as a dynamic space with arbitrarily chosen dimensions built through qualitative analysis and an ability to sustain open dynamic systems.

This assumes an architecture representative of some changing connectivity of patterns over time (Allen, Stacey, and Bar-Yam 2017) and the presence of a system that can be partitioned into independent subsystems without forcing their closure. Complexity science embraces this openness when it comes to application and development of new inroads to understanding and theory development. While the same irreducible representations might end up as a linear combination of induced characters, this structure is representative of heterogeneous layers and a repeatable process, which equates it to a complex

and nonlinear hierarchical relationship. This is worth mentioning because as dimensionality is reduced and levels of abstraction naturally increase, linear approaches become severely restricted as more data is removed.

Given that elements of thermodynamics are present in both the information domain and the resultant system that is the center of some sort of analytic focus, as suggested here, thermodynamic depth helps us define the benefits of borrowing some of these concepts. In this way, such depth is the most plausible scientific path leading to the thing itself (Mitchell 2009); that path is the movement toward shaping an implex state accompanied by a general rise in systemic entropy and its relation to the amount of complexity at hand. Since more complex items are harder to construct, striving for emergent simplicity in this way folds itself into any analytical process designed to engender the familiar based in a systems of systems approach through identification of a center of initial focus. One does not have to measure a construct to use it, and the data science and mathematical elements of this profile are designed to unemotionally move and construct representative fractals within discursive spaces.

While the linkages between fractals and information salience are developing, the relationship between meaning and spatio-temporal transients of events suggests connectivity between abstract shape and value. While these are geometric standards, fractals represent a self-organized portion of their host system so the designation of an abstract center is not an overextension of the latter's previously accepted function. These traits represent the best nexus between the choices above, specifically the fractal designation and application of nonlinear constructivism. This means that comparison and inclusion as done here, specifically the linkage between fractals and discursive spaces, is scientifically correct.

This approach is not a blind adherence to such connections despite such a fit, as any study that ignores the risk of failure deserves the designation of a philistine undertaking. Even if this comparison introduces an off-ramp to more extensive discussions exceeding the limits of this summation, there is an undeniable connection to complexity and CAS, and an unrelenting validity in both complexity science and extractions from the second law of thermodynamics. All of which —as general premises—are accepted ingredients within national security circles.

The nondeterministic nature of this approach reveals itself through its ability to let complex systems continue their behavioral momentum. This means that it would be difficult, if not disciplinarily inappropriate, to expect determinism as the correct output as any precondition other than situational connectivity. The resultant state is nondeterministic since there is no effort to shift the entire system or predict future states, as this methodology is not broadly aimed at supervising a system. While the methodology here is scientifically valid, the treatment of it as a nonlinear

hierarchy is new, and therefore reflective of the emergent complexity label.

As an effort to illustrate such potential, the following list of key findings serves to justify and advance the profile offered by this study:

- The intersections between information theory, linear approaches, and nonlinear approaches are precisely separated, and the advantages of moving deeper into nonlinear construction appear well poised to fill that gap.
- Cyberspace is a complex, dynamic system, at times representative of emergent simplicity and at other times representative of emergent complexity.
- Hierarchical relationships transcend the presence of dimensionality, measures of entropy, and the application of nonlinear approaches.
- Integrative complexity and the laws of thermodynamics maintain an open nature, and each has a broad history of application among emergent theories specifically designed to not limit future theory development.
- Fractals are indicative of exactly the type of progressive shape required to designate a center within the information domain and they assist in qualitative organization.
- Analytic techniques traditionally depend on linear approaches but suffer significant disconnects when involved with higher dimensional environments.
- The proper identification of an analytic center requires movement toward an implex state.
- Discursive spaces purposely allow for selective knowledge integration within a system.

Selecting referential processes from the bounds of normal within the second law of thermodynamics is not a biased inclusion since there is no assertion that it can or should represent a control theory. Select portions of the second law are used as formation for this approach and purposeful control would result in a reversion to linear boundaries. Such an approach has two implications; first, generation of a higher construct is a physical output key to advanced analysis and second, the de-evolution of that construct when time no longer situationally provides value is proof that this construction can be reversed on the path to theory generation.

Absent confirmation of acceptance, this study resides specifically in the metaphysical, while advancing several lines of blended thought seeking to discard binary categorization. This is not a replacement for reality, nor is it a suggestion that such a radical move supersedes appropriate technical development; such mechanical design is the next logical step, even though the essence of this work represents some distance from full-on automation. The unpredictable nature of human ability and the blithe acceptance of those machine outputs is a dangerous trend within the tradecraft of analysis and any discipline that any structured examination touches.

References

Allen, B., B. Stacey, and Y. Bar-Yam. 2017. "Multiscale Information Theory and the Marginal Utility of Information." *Entropy* 19 (6): 273–311. https://doi.org/10.3390/e19060273.

Fellman, P. 2014. *The Complexity of Intelligence Estimates.* Unpublished manuscript. Boston, MA: Sawyer Business School, Suffolk University.

Jacobson, R.A. 1967. "Spaceland as Viewed Informally from the Fourth Dimension." *Mathematics Magazine* 40 (4): 174–78. http://www.jstor.org/stable/2688672.

Maciag, R. 2018. "Discursive Space and Its Consequences for Understanding Knowledge and Information." *Philosophies* 3 (4): 34. http://dx.doi.org/10.3390/philosophies3040034.

Mitchell, Melanie. 2009. *Complexity: A Guided Tour.* Oxford: Oxford University Press.

Sennet, A. 2012. "Semantic Plasticity and Epistemicism." *Philosophical Studies* 161 (2): 273–85. http://dx.doi.org.nauproxy01.national.edu/10.1007/s11098-011-9734-1.

Sulis, W. 2019. "Transients as the Basis for Information Flow in Complex Adaptive Systems." *Entropy* 21 (1): 94–107. https://www.mdpi.com/1099-4300/21/1/94.