Journal of Physics & Astronomy

Short Communication| Vol 6 Iss 1

Information Geometric Techniques for Complex Systems

Demetris Ghikas PK*

Department of Physics, University of Patras, Patras, Greece

***Corresponding author:** Demetris Ghikas PK, Department of Physics, University of Patras, Patras, Greece, Tel: +0306972268044; E-mail: ghikas@physics.upatras.gr.

Received: March 23, 2018; **Accepted:** April 07, 2018; **Published:** April 11, 2018

Abstract

A system can be defined as complex if it is not equal to the sum of its parts. Even without defining the meaning of the concept "sum", it is generally understood that most natural or man-made systems are complex. But complex is not the same as complicated. The latter can be defined and quantified, but complexity needs first a concrete qualitative characterization. There exist various approaches but the minimal ones are not widely applicable. Since complexity, whatever its definition is employed, is nearly always associated with uncertainty and probabilistic quantities, it is natural to consider quantities inherently related to information.

***Keywords*: Geometry; Parameters; Boltzmann**

Short Communication

A system can be defined as complex if it is not equal to the sum of its parts. Even without defining the meaning of the concept "sum", it is generally understood that most natural or man-made systems are complex. But complex is not the same as complicated. The latter can be defined and quantified, but complexity needs first a concrete qualitative characterization. There exist various approaches but the minimal ones are not widely applicable.

Since complexity, whatever its definition is employed, is nearly always associated with uncertainty and probabilistic quantities, it is natural to consider quantities inherently related to information. These quantities are entropy like, both of the usual Shannon and Boltzmann type, and also related to many generalizations of entropic quantities. Accepting such a probabilistic framework the next step is to enter in the realm of Information Geometry [1-10].

This is a Geometry of probability distributions. Concepts of distance and curvature are then available for estimation and discrimination purposes. We have used the generalized two-parameter entropy of Hanel and Thurner to construct an information manifold. We approached the problem from two different points of view. We first considered the associated

Citation: Demetris Ghikas PK. Information Geometric Techniques for Complex Systems. J Phys Astron. 2018; 6(1):145

distribution of discrete probabilities and used the two parameters to characterize and classify complex systems in five classes with different quantitative properties. In the second point of view we considered an information manifold with the two parameters playing the role of coordinates.

The derived scalar curvature has regions of strong variation along special curves on the manifold where the curvature is maximal or minimal. These curves give pairs of parameters which we conjecture are associated to complex systems with special properties. We need a deeper understanding of this behavior, and a rigorous approach to singularities which appear in our numerical calculations [11-16].

REFERENCES

1. Abe S. Geometry of escort distributions. ARXive: Cond-Mat. 2003.
2. Amari S, Nagaoka H. Methods of Information Geometry. Oxford University Press : AMS. 2000.
3. Amari S, Atsumi O. Entropy. 2011;13:1170-85.
4. Amari S, Atsumi O, Hiroshi Matsuzoe. Physica A. 2012; 391:4308-19.
5. Ay N, Eckehard O, Nils B, et al. Chaos. 2011; 21:037103.
6. Ghikas DPK, Oikonomou FD. Physica A. 2018; 496:384-98.
7. Ghikas DPK, Oikonomou FD. Submitted for publication. 2018.
8. Hanel R, Thurner S. EPL. Physica A. 2011; 93:206.
9. Hanel R, Thurner S. ArXive. Physica A. 2013: 1310:5959v1.
10. Hanel R, Thurner S. Is there a world behind Shannon? Entropies for complex systems. In: Interdisciplinary Symposium on Complex Systems Emergence. Complexity and Computation A. 2013.
11. Hanel R, Thurner S. Physica A. 2007; 380:109-14.
12. Hanel R, Thurner S. Brazilian Journal of Physics. 2009; 39:413-416.
13. Naudts J. Estimators escort probabilities. Phi-exponential functions in statistical physics. ArXive: Math. 2004; 042005.
14. Tsallis C, Mendes RS, Plastino AR. Statistical physics. Physics A. 1998; 261:534-54.
15. Tsallis C. Introduction to non-extensive statistical mechanics. Springer. 2009.
16. Tsallis C. Non-extensive statistical mechanics: Construction and physical interpretation: M Gell-Mann. Oxford. 2004.