# IS EXTRA-TERRESTRIAL INTELLIGENCE POSSIBLE? AN APPROACH USING COMPLEX SYSTEMS THEORY ON THE COMPUTATION OF THE PROBABILITY FOR THE EMERGENCE OF INTELLIGENCE.

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## Abstract

Much has been said about the possibility of extra-terrestrial life. Some state that, due to the almost impossibility of extra-terrestrial life existence, extra-terrestrial intelligence emergence is virtually impossible.

In this paper we state that intelligence is not only possible in planets with any kind of life but also that, once life emerges, intelligence is an almost inevitable consequence [1].

If we consider a universe of elements with the capability of interacting we are in the presence of a system [2]. Using this concept of system we can establish the optimal states, in a neighbourhood, for which intelligence emergence is possible. It is then possible to obtain the probability of a system to reach those optimal states.

In the end, we prove that reaching such points is actually inevitable since they are the most probable cases because two driving forces will imply reaching optimal states.

Such forces are the entropy maximization necessity, which is a direct consequence of the second principle of thermodynamics, and the relativistic information maximization [3][4][5][6][7], which will be a measure of the system intelligence and, therefore, is used as a

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natural selection factor. The optimal states, due to the influence of such forces, are, therefore, stable points in evolution [8][9][10].

Other principles must be taken in account. To do so is to diminish the set of optimal solutions of any m agents, n connections system. Such principles, such as the least energy principle [11], applicable to the required energy to create the system, will function as secondary forces to choose a smaller set of optimal solutions from the set of solutions previously obtained.

Each time a new condition is added the set of optimal solutions becomes smaller. Nevertheless it is not expected to reduce such set to only one solution.

Complex Systems are known for having the ability to exhibit many “unexpected behaviours” and adopt many solutions. Therefore, our goal consists only in determining optimal states within small neighbourhoods of possible states.

The determination of all optimal states involves many difficulties, mainly topological, due to the huge number of possible states [12]. Therefore a method or algorithm, able to simplify such quest is imposed.

Our method allows the establishment of the optimal number of interactions, considering as optimal number the one for which thermodynamic entropy is minimal and capacity to store information is maximal [10][11]. Such method consists in:

1) From previous works we know the conditions and, therefore, the rules, to obtain optimal states for any m agents, n connections system, capable of adopting any structure.

The two most important conditions are given by:

$Ns = [m.(m-1) / 2] + 1$ (1) – Number of states

$\forall k \in N, \forall 0 < n_k < m.(m-1)/2: n_k = k.m \wedge n_k = n_{max} - n_k$ (2) - Optimal States

2) With such knowledge we are capable to estimate the number of all possible states of the system.

3) We determine, according to the conditions for intelligence emergence, the number of optimal states and, from that, its probability of occurrence in a system with no preferential structure.

Since states are not all equally probable and establishing the driving forces of evolution, we end by proving that the most probable states are also the optimal ones, thereby explaining its relatively fast emergence on Earth and predict the probable emergence anywhere else where agents can connect themselves to create systems, provided that simple agents can start creating any sort of interaction between them.

[1] ”Investigations”, Stuart A. Kauffman, Oxford University Press, 2000.
[2] ”Hidden Order”, J. Holland, Addison Wesley, 1995.
[3] Carvalho Rodrigues, F., 1989. “A proposed entropy measure for assessing combat degradation”, J. Opl. Res. Soc. (UK), **40** (8): 789-93.
[4] Carvalho Rodrigues, F., Dockery, J., Woodcock, A.E.R. 1992, “Models of combat with embedded command and control: Casualty based entropy calculations as a combat predictor”, chapter 2.5, in: *The Military Landscape, Mathematical Models of Combat*, Woodhead Press, Cambridge, UK.
[5] Carvalho Rodrigues, F., Dockery, J. and Rodrigues, T., 1993b, “Entropy of Plagues: A Measure Assessing the Loss of social Cohesion Due to Epidemics”, European J. of Operational Research, **71**, 45-60.
[6] Carvalho Rodrigues, F., Dockery, J., 1996, “Defining Systems Based on Information Exchange: Structure from Dynamics”, BioSystems **38**,229-234.
[7] Carvalho Rodrigues, F.,1990/1991, “Função de Coesão de Estruturas baseadas em Informação”, Memórias da Academia, TOMO XXXI, Academia das Ciências de Lisboa.
[8] ”Comparative Mammalian Brain Collections”, http://www.neurophys.wisc.edu/brain/evolution/index.html/
[9] ”Fossil Hominids: the evidence for human evolution”, http://www.talkorigins.org/faqs/homs/
[10] “Cálculo do Consumo Energético e Capacidade de Armazenamento de Informação em Sistemas Complexos”, F. Carvalho Rodrigues, André S. Ribeiro, Setembro de 2002, Conferencia Nacional de Física 2002 in Portugal.
[11] The Cost in Energy and in Time of the Intelligence”, F. Carvalho Rodrigues, André S. Ribeiro, Scientific Annals of UnI, Vol 2, no. 3, Winter 2001
[12] H. J. Bremermann, "Complexity and transcomputability", in *The Encyclopedia of Ignorance*, M. Duncan, ed. Pergamon Press, Oxford (1977).