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Ontogenesis and phylogenesis of discrete dynamical systems: cellular automata

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Abstract

The concept of *ontogenesis* is related with the emergence and the development of an organism. A process is called ontogenetic if it refers to continuous changes observable on a single organism - development from a simpler to a complex form or state. A paradigmatic example is the embryonic development or morphogenesis.

On the other hand, *phylogenesis* is related to the emergence of stable characteristics in populations of organisms. A process is called phylogenetic if there is a population which interacts with an environment, the individuals of the population interact between themselves and the change is revealed both in the individuals and in the characteristics of the population globally.

In discrete dynamical systems, ontogenesis refers to the transformation process of a dynamical system, therefore, in a certain sense we can say we are considering a dynamical system where the state space is a set of discrete dynamical systems. In other words, we study changing dynamical systems. Phylogenesis, refers to populations of discrete dynamical systems with certain common characteristics. Interactions between the individual dynamical systems must be considered, in particular, certain recombination process.

Cellular automata are discrete dynamical systems, with $\mathbb{Z}_n$ as local state space, and each cellular automaton is characterized by a finite sequence of elements in $\mathbb{Z}_n$, determining the time evolution rule. This sequence is seen as the *genotype* of the cellular automata. Therefore, the space of cellular automata of n local states can be seen as the set of finite sequences, of certain size m, in $\mathbb{Z}_n$, that is $\mathbb{Z}_n^m$. Recombination in cellular automata is a process analogue to the occurring in the DNA of living beings through the reproduction process ([1]).

We review some results on cellular automata. In particular, we introduce the concept of regulatory dynamics through an analogy with introns and exons, of DNA, and the comparative study between biological concepts and dynamical concepts

Keywords: Ontogenesis, phylogenesis, discrete dynamical systems, cellular automata.

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References

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