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Redes de reacciones y el modelamiento ecológico a gran escala

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Resumen

The decline of the Earth's biodiversity is a threat to the ecosystems in the planet. Ecological systems are faced with species extinctions and invasions and one fundamental question is how systems vary when they suffer these changes. The latter problem has motivated the study of ecological systems at large scale [1]. For example, it is important to know how ecosystem features such as resilience, resistance, robustness, or in wider terms, stability respond to changes in species diversity, richness, connectivity, or in wider terms, complexity [2]. However, current ecological modeling approaches have not been able to tackle simultaneously the following three requirements: i) Incorporating multiple entities and multiple types of interactions ii) Computational feasibility iii) Appropriate analytic tools [3].

We present a novel approach to represent ecological systems using reaction networks, and show how a particular framework called Chemical Organization Theory (COT) meets the above requirements [4, 5]. Ecological interactions are expressed as reaction networks, whose species can be the ecological species, resources, or other types of elements that condition the interactions. Hence, the ecological system is represented by a large reaction network that integrates all interactions. Next, given this large set of species and their interactions, COT identifies, in a computationally feasible way, each and every sub-collection of species that is closed and self-maintaining. These sub-collections, called organizations, correspond to the groups of species that can survive together (co-exist) in the long-term. Thus, the set of organizations contains all the stable regimes that can possibly happen in the dynamics of the ecological system. From here, we propose to conceive the notion of stability from the properties of the organizations, and thus apply the vast knowledge on the stability of reaction networks to the study of ecological systems. We will discuss some examples of ecological systems and present a software developed by ourselves for COT-analysis of ecological systems.

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