Chemical Organisation Theory

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Abstract

Complex dynamical reaction networks consisting of many components that interact and produce each other are difficult to understand, especially, when new component types may appear and present component types may vanish completely. Inspired by Fontana and Buss (Bull. Math. Biol., 56, 1–64) we outline a theory to deal with such systems. The theory consists of two parts. The first part introduces the concept of a chemical organisation as a closed and self-maintaining set of components. This concept allows to map a complex (reaction) network to the set of organisations, providing a new view on the system's structure. The second part connects dynamics with the set of organisations, which allows to map a movement of the system in state space to a movement in the set of organisations. The relevancy of our theory is underlined by a theorem that says that given a differential equation describing the chemical dynamics of the network, then every stationary state is an instance of an organisation. Applications of this theory to evolution will also be discussed, and possibly its application to small model of HIV-immune system interaction by Wodarz and Nowak (Proc. Natl. Acad. USA, 96, 14464–14469) and to a large model of the sugar metabolism of E. Coli by Puchalka and Kierzek (Biophys. J., 86, 1357–1372). In both cases organisations where uncovered, which could be related to functions.

Biographical Information

Dr. Pietro Speroni di Fenizio is a Post-doc in RINCE’s Artificial Life Laboratory. He received his PhD from Jena in bioinformatics. He originally came from Italy, where he did his Laurea (basic degree) in Mathematics after which he proceeded to do a Master in Evolutionary and Adaptive Systems at Sussex University, followed by a PhD in Jena.. He has been consistently working in the areas of artificial life, systems biology and in general algebraic models of biological systems.