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Abstract

P systems with active membranes use evolution, communication, dissolution and division (or separation) rules. They do not use cooperation neither priorities, but they have electrical charges associated with membranes, which can be modified by rule applications. The inspiration comes from the behavior of living cells, who "compute" with their proteins in order to obtain energy, create components, send information to other cells, kill themselves (in a process called *apoptosis*), and so on. In these models, *mitosis* is simulated by *division* rules (for elementary and non-elementary membranes) and *meiosis*, that is, membrane fission inspiration, is captured in *separation* rules. The parent's objects are replicated into both child membranes when a division occurs, while in the case of separation, objects are distributed (according to a prefixed partition). In both cases, active membranes have been proved to be too powerful for solving computationally hard problems in an efficient way. Due to this, polarizationless P systems with active membranes have been widely studied from a complexity point of view.

Evolution rules simulate the transformation of components in membranes, but it is well known that in Biology elements interact with each other in order to obtain new components. In this paper, (restricted) cooperation in object evolution rules is considered, and the efficiency of the corresponding models is studied.

Key words: Membrane Computing, Active membranes, Minimal cooperation, Mitosis, Computational Complexity, The **P** versus **NP** problem.

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