Information Threshold and Compartmentalization: limited diffusibility and small population size counteract group selection *

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Abstract

Eigen has shown that there is a paradox in prebiotic evolution, the so called information threshold (or error threshold). The paradox is as follows: an accurate complex replication mechanism needs enough coded information, and enough information needs an accurate enough replication mechanism. Both need each other to emerge, and both are not likely to emerge at the same moment.

As a solution to this paradox, Szathmary proposed compartmentalization of a replicator system in the so called Stochastic Corrector Model. In this model, stochasticity in the dynamics and group selection enhance the coexistence of multiple species of replicators, and thus may facilitate the emergence of more complex replicators. However, the compartmentalization imposes limited diffusibility and small population size on the replicator dynamics, and both are known to reduce the information threshold and thus decrease the amount of information which can be kept.

Here, we study the overall effect of the compartmentalization on the information threshold of one single species. We made a comparison between a simple non-interacting self-replicator system with and without compartmentalization. We introduce a two dimensional two layer Cellular Automata model, in which replicators and compartments are explicitly represented. The simulation results showed that, in the case that the replicators do not have any difference in functions with regard to the compartment dynamics, group selection was not strong enough to compensate the two other effects. Compartmentalization reduced the information threshold, and thus decreased the amount of information which can be kept in one species of self-replicators. The results also showed that the spatial pattern formation on the compartment level also reduced the information threshold.

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