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Achieving Closure in Enzymes in Artificial Chemistries

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Abstract

Previous work has shown simulations of self-reproducing cells within the framework of a two-dimensional artificial chemistry. This earlier work used either a set of fixed rules to produce specific behaviors, or atomic enzymes governed by an extended set of meta rules. The difficulty with such enzymes is that their method of operation is outside of the system and thus cannot itself be reprogrammed by enzymes, unless another meta-level of rules is added - the system lacks closure.

Here we generalize the rules by introducing molecular enzymes that have catalytic functions capable of being extended to the very same components of enzymes themselves, without changing the underlying system rules. This allows for a pool of enzymes to reproduce themselves while remaining fully embedded in the arena of competition. Together with the limited availability of components this permits each organism to become a resource for the others, thus enabling rich interactions between the organisms not only via their shared environment (e.g. waste products) but also directly (e.g. attacking each other). With stochastic mutations we suggest that the ingredients are thus in place for open-ended evolution.

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