A Cellular Automaton Approach for Modeling Chemical Reactions in Protein Synthesis

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Self-reproduction is an important topic in the field of cellular automata (CAs), since the original CA model has been invented with the purpose to formalize biological self-reproduction [1]. Various self-reproducing machines on CAs have been proposed, such as universal constructors [1] and self-reproducing loops [2], resulting in the realization of simpler self-reproduction mechanisms [3,4]. However, there have hardly been investigations on self-reproduction that employs biologically realistic self-reproduction, such as chemical reactions in the protein synthesis.

This paper explores self-reproduction from a more biological point of view by modeling and simulating the chemical reactions in protein synthesis of biological systems. To this end we adopt a Brownian cellular automaton (BCA), which is a type of asynchronous CAs in which fluctuations drive operations. A BCA with an appropriately designed transition function can deal with both random processes, such as proteins flowing over an area, and sequential processes, such as synthesizing messenger RNAs [5]. There are four stages in the process of protein synthesis: the reproduction of DNA strands, the transcription from DNA strands to RNAs, the synthesis of messenger RNAs by a splicing process, and the synthesis of proteins. All these processes are modeled in this paper through the use of BCAs.

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