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ONE-WAY TOPOLOGICAL AUTOMATA AND THE TANTALIZING EFFECTS OF THEIR TOPOLOGICAL FEATURES

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ABSTRACT

We cast new light on the existing models of one-way deterministic topological automata by introducing a fresh but general, convenient model, in which, as each input symbol is read, an interior system of an automaton, known as a configuration, continues to evolve in a topological space by applying continuous transition operators one by one. The acceptance and rejection of a given input are determined by observing the interior system after the input is completely processed. Such automata naturally generalize one-way finite automata of various types, including deterministic, probabilistic, quantum, and pushdown automata. We examine the strengths and weaknesses of the power of this new automata model when recognizing formal languages. We investigate tantalizing effects of various topological features of our topological automata by analyzing their behaviors when different kinds of topological spaces and continuous maps, which are used respectively as configuration spaces and transition operators, are provided to the automata. Finally, we present goals and directions of future studies on the topological features of topological automata.

Keywords: topological automata, topological space, continuous map, compact, discrete topology, Kolmogorov separation axiom, quantum finite automata

1. Prelude: Background and Current Challenges

1.1. A Historical Account of Topological Automata

In the theory of computation, *finite-state automata* (*finite automata*, or even *automata*, for short) are one of the simplest and most intuitive mathematical models to describe "mechanical procedures," each of which depicts a finite number of "operations" in order to determine the membership of any given input word to a fixed language. Such procedures have clear resemblance to physical systems that make

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