On oriented hypergraphs and on dynamics of some discrete systems

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In the early 60's there was a surge of papers dealing with growth, self-reproduction, self-repair, etc., of automata. These notions were often discussed in the framework of the "classical" theory of automata, i.e. theory which deals with automata whose inputs and outputs are considered to be words over certain finite alphabet. In other cases, special frameworks for this purpose were created, namely tessalations, and many results were obtained in this way. However both these approaches had certain limitations and it is now apparent that a new, more general framework, is needed.

In this paper, we attempted to generalize both the theory of automata and of tessalations. The basic mathematical structure used is that of oriented hypergraphs with labeled edges. This structure can be alternatively thought of as a set and some set of relations on it. This structure is well suited for our purposes, namely for its intuitive appeal, immense generality and flexibility, and also for its potential in description of the real world, consisting of interrelated objects.

It is also necessary to represent time and change. For this purpose, we adopted the so-called "productions", which are capable of representing "local" change in a hypergraph, i.e. a change affecting finite number of nodes and edges at any given time. System is defined by an original hypergraph and a set of such productions.

It is demonstrated that Turing machines, context-free grammars, and tessalations can be simulated by systems. Several unsolvability results are derived in this way.

Next a configuration is defined, i.e. a part of a hypergraph with certain properties. Several related and important notions are investigated: interaction, growth, self-reproduction, etc. Several algorithms and complexity estimates are given.

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