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# IMPLEMENTATION OF PARALLEL REPLACEMENT SYSTEMS FOR CELLULAR HYPERGRAPHS [1]

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ABSTRACT

This paper gives an overview about the concept of *cellular hypergraphs* and *parallel replacement systems* for these graphs. A versatile *addressing model* is presented which can be used to perform computations on state values associated with a graph. The same addressing model is the key to an efficient *subgraph matching* algorithm. This algorithm demonstrates that the presented concept can be applied to real world problems. Cellular hypergraphs with replacement systems are a generalization of the cellular automata (CA) paradigm which constitutes an inherently massive-parallel model of computation. The usage of a set of productions instead of a CA's local transition function allows us not only to formulate state transitions, but furthermore temporal modifications of the cellular structure itself. Consequently the concept can be used as an abstract model of computation for those applications which are based on irregular and dynamically changing meshes, i. e. the simulation of biological systems, dynamic sceneries in computer graphics and adaptive mesh generation algorithms.

*Keywords:* Multidimensional and dynamic cellular structures, graph replacement systems, relative spatial addressing, subgraph matching.

## 1. Introduction

The implementation of computer based simulations can profit from formal methods since they allow us to proof characteristics of the implementation and they simplify the application of specialized computer hardware. For example, the work of TOFFOLI and MARGOLOUS presented in [13] demonstrates that cellular automata (initially introduced by J. VON NEUMANN [11] for theoretical investigations) can be used as an abstract model of computation for the simulation of those natural systems which can be embedded into a regular grid. Cellular automata operate inherently massive-parallel and can be easily implemented on a parallel computer system. Consequently if an application can be described as an CA based model, its implementation on a parallel computer hardware can be done straight forward.

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