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The Dynamic Structure Cellular Automata (DSCA): An innovative approach for the modeling and simulation of propagation phenomena

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In natural spaces, propagations (floods, pollution, fires, constructions, etc.) occur on a structure, which is: highly heterogeneous (in behavior and topology), embedding massive data, and "open-frontier". Simulating such phenomena on computers necessitates ergonomics and optimizations of computational and formal models for efficient and facilitated implementations. Dynamic Structure Cellular Automata (DSCA) [1] constitute an innovative approach for modeling and simulating propagation phenomena. They provide a formal guide and a software architecture for modeling and simulation. Compared to usual cellular automata, every cell's structure can be changed during a simulation. Heterogeneous behaviors (corresponding to specific neighborhoods) can be changed dynamically. Besides, activity (state changes in cells) can be tracked, a global transition can be specified, and external discrete events can be grasped. According to phenomenon evolutions, characteristics of cells can be changed dynamically (a burning cell can change its connections to influence remotely other cells by radiation). Reusing DSCA components allows to connect them easily to other interacting systems. Tracking activity reduces execution times by focusing computations in space on active components. Hence, whatever the space dimension, computations are performed only into activity regions. A global transition function can be specified based on the global state of the system. Discrete events can be tackled during a discrete time simulation (e.g., firebrand ignitions occurring at continuous times during the simulation). Based on the Discrete EVent System Specification (DEVS) framework [2], DSCA allow to enhance efficiency and ergonomics of simulation systems. Modifications and reuses are facilitated by the use of interconnected components (implemented using object-oriented programming). In this paper, we propose to introduce discrete

event modeling and simulation. Then, we aim to present DSCA through their formal and software structure. Lastly, application cases of fire spread simulations could be discussed.

References 1. Muzy, A., E. Innocenti, D.R.C. Hill, A. Aïello, J.F. Santucci, P.A. Santoni. Dynamic structure cellular automata in a fire spreading application. in First International Conference on Informatics in Control, Automation and Robotics. 2004. Setubal, Portugal: IEEE/CSS/IFAC/ACM/AAAI/APPIA, pp. 143-151. 2. Zeigler, B.P., H. Praehofer, and T.G. Kim, Theory of modelling and simulation. 2000: Academic Press.