Cellular Modeling with Cell-DEVS: a Discrete-Event Cellular Automata formalism

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Recent advances in computer technology have influenced simulation techniques to become an effective approach to understand physical systems. In recent years, grid-shaped cellular models have gained popularity in this sense. In particular, Cellular Automata (CA) have been widely used with these purposes. Despite their usefulness to describe complex behavior, complex cell spaces based CA can require large amounts of compute time, mainly due to its synchronous nature. The use of a discrete time base also constrains the precision of the model. The Cell-DEVS formalism is an extension to Cellular Automata was defined in order to deal with these issues. The goal of Cell-DEVS is to build discrete-event CAspaces, improving their definition by making the timing specification more expressive.

We will show how to improve CA definition through Cell-DEVS, focusing on varied examples on how to model complex CA in a simpler way. We will present different examples of application, and discuss open research issues in this area. We will start with an introduction to different models in physics (diffusion, binary solidification, excitable media, surface tension, etc.). We will discuss modelling different artificial systems: traffic, wireless networks, sensor networks, and mobile communication (LTE networks). We will then show some examples of the current use of the methodology in natural systems: model of heart tissue simulation, ant foraging systems, synapsin-vesicle interaction in nerve terminals, CA for CFD in models of artery clogging, etc. We will discuss advanced examples orchestrating CA, a GIS and data visualization. We will present the use of this discrete-event CA to model forest fires, watershed formation and floods. We will focus in showing how the application of these techniques can improve model definition. We will also focus in describing how to create models that can be executed automatically in a parallel environment without any modifications to the original models, or user intervention. We will finally discuss current open topics in the area, which include advanced methods for centralized, parallel or distributed execution of the CA models.

Bio:

GABRIEL A. WAINER, *SMSCS, SMIEEE, received the M.Sc. (1993) at the University of Buenos Aires, Argentina, and the Ph.D. (1998, with highest honors) at the Université d'Aix-Marseille III, France. In July 2000 he joined the Department of Systems and Computer Engineering at Carleton University (Ottawa, ON, Canada), where he is now Full Professor. He has held visiting positions at the University of Arizona; LSIS (CNRS), Université Paul Cézanne, University of Nice, INRIA Sophia-Antipolis (France); UCM, UPC (Spain) and others. He is the author of three books and over 280 research articles; he edited four other books, and helped organizing numerous conferences, including being one of the founders of SIMUTools and SimAUD. Prof. Wainer is the Vice-President Conferences, and was a Vice-President Publications and a member of the Board of Directors of the SCS. Prof. Wainer is the Special Issues Editor of SIMULATION, member of the Editorial Board of IEEE Computing in Science and Engineering, Wireless Networks (Elsevier), Journal of Defense Modeling and Simulation (SCS), and International Journal of Simulation and Process Modelling (Inderscience). He is the head of the Advanced Real-Time Simulation lab, located at Carleton University's Centre for advanced Simulation and Visualization (V-Sim). He has been the recipient of various awards, including the IBM Eclipse Innovation Award, SCS Leadership Award, and various Best Paper awards. He has been awarded Carleton University's Research Achievement Award (2005), the First Bernard P. Zeigler DEVS Modeling and Simulation Award, the SCS Outstanding Professional Award (2011) and Carleton University's Mentorship Award (2013), the SCS Distinguished Professional Award (2013) and Carleton University's Research Achievement Award (2014).*