Sleptsov Net Computing Advances

Dmitry A. Zaitsev

The University of Derby, UK

Abstract

A Sleptsov net represents a generalization of a Petri net that allows multiple firings of a transition in a single step. Compared to a Petri net, it runs exponentially faster and is Turing-complete, which open prospects for its application as a graphical language for concurrent programming. We offer a uniform concept entirely built of Sleptsov nets with transition substitution, using text for net names and comments only. After formal verification, we compile Sleptsov net programs into C and Verilog code for embedded applications, enabling their execution on microcontrollers and FPGAs. We compose Sleptsov net virtual machines on multicore CPUs and GPUs, seeking efficient approaches to their dedicated hardware implementation. By combining multiple firing of a transition (the Sleptsov rule) with the maximal firing strategy (the Salwicki rule), we reduce the number of required steps, efficiently approximating the maximal multiset of fireable transitions in a step. However, global synchronization by steps hampered further advances. Recently, we revealed an intrinsic connection between System V semaphores and place-transition nets and introduced novel (stepless) semantics, in which places represent semaphores and transitions represent processes (threads), each repeatedly performing a single System V operation over Dijkstra semaphores corresponding to the transition's incident arcs. An operating system kernel, real or hypothetical, is considered a formal system. This opens prospects for fast asynchronous hardware and software implementations of the corresponding graphical language for concurrent programming.

Basic references

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Bio



Dmitry A. Zaitsev (University of Derby, UK) developed: analysis of infinite Petri nets with regular structures; decomposition of Petri nets into clans; generalised neighbourhood for cellular automata; and method for synthesis of fuzzy logic functions given by tables. He designed: Opera-Topaz software for manufacture operative planning and control; a new stack of networking protocols, E6, and its implementation within the Linux kernel; and Petri net analysis software Deborah, Adriana, and ParAd. He developed models for TCP, BGP, IOTP protocols and for Ethernet, IP, MPLS, PBB, and Bluetooth networks. His current research interests include Petri net theory and its applications in networking, computing, and automated manufacturing. Recently, he started working in the area of exascale computing, applying his theory of clans to speed up solving sparse linear systems on parallel and distributed architectures, as well as developing a novel paradigm of Sleptsov net computing. He has been a co-director of joint projects with Slovakia, China, and Austria. He has been a visiting professor at the Technical University of Dortmund, Germany on a DAAD scholarship; the University of Tennessee, Knoxville, USA on a Fulbright scholarship; Eindhoven University of Technology, Netherlands; Johannes Kepler University, Linz, Austria; Cote D'Azur University, Nice, France; and the Technical University of Darmstadt, Germany. He has published a monograph, six book chapters, and more than a hundred papers, including those listed in JCR and CORE A. He is a senior member of ACM and IEEE.

Info about Anatoly Sleptsov:
https://www.linkedin.com/posts/dmitry-a-zaitsev_sleptsovnets-parallelcomputing-parallelprocessing-activity-7503014998055723008-UbDx