M2 and PhD subject

Title : Well Structured FIFO Automata

Supervisor

Alain Finkel
Téléphone : Alain Finkel : 01 47 40 75 69
Email : finkel@lsv.ens-cachan.fr
Laboratoire Spécification et Vérification
Ecole Normale Supérieure de Cachan
61, avenue du Président Wilson
94235 Cachan CEDEX

Key words

Automata, infinite-state systems, verification, decidability, algorithmics, logic, well structured transition systems, FIFO mechanism

General Context

The theory of *Well Structured Transition Systems*, (WSTS) allows the automatical verification of infinite-state systems, that can be finitely represented and tested [5, 8, 6]. Termination, boundedness and coverability (the coverability problem is a variant of the reachability problem : it remains to decide whether there exists a reachable state in the upward closure of a given state) are decidable for WSTS.

For complete WSTS [6], the Karp and Miller algorithm [11, 6] computes the finite set of maximal elements of the downward closure of the reachability set. This algorithm logs a state space exploration of the reachability set with a finite tree, allowing to decide safety and liveness problems.

FIFO automata is a powerfull model since the FIFO mechanism allows to simulate the tape of turing machines. Various decidable classes of FIFO automata have been studied. However, there exist today no satisfying characterization of well structured FIFO automata.
We propose a systematic study of well structured FIFO automata.

Objectives

1. Survey the litterature about FIFO automata : monogeneous [5], linear [7], word linear [10], half-duplex [2], cyclic [1] and lossy FIFO automata [3, 9, 4].

2. Find and analyse the different classes of well structured FIFO automata associated with different orders on Σ^* as the prefix ordering, the subword ordering,...

Location

This internship will be supervised at the Ecole Normale Supérieure de Cachan.

Qualifications and Connections

Ideally, the candidate holds a Master degree in Computer Science (with courses in formal verification, theoretical computer science and mathematical structures for CS) or equivalently is graduated from a Computer Science Engineering School with a strong background in theoretical computer science.

This research program is directly connected to MPRI C2-9 course, on *Mathematical foundations of the theory of infinite transition systems*. It should suit a theoretically-minded student with some taste for theoretical and algorithmic constructions. The internship is an ideal opportunity for starting a PhD thesis (possible collaborations with Bordeaux and Montréal).

Références

[1] Ahmed Bouajjani and Peter Habermehl. Symbolic reachability analysis of fifo-channel systems with nonregular sets of configurations. *Theor. Comput. Sci.*, 221(1-2) :211–250, 1999.

[2] Gérard Cécé and Alain Finkel. Verification of programs with half-duplex communication. *Information and Computation*, 202(2) :166–190, November 2005.

[3] Gérard Cécé, Alain Finkel, and S. Purushothaman Iyer. Unreliable channels are easier to verify than perfect channels. *Information and Computation*, 124(1) :20–31, January 1996.

[4] Pierre Chambart and Philippe Schnoebelen. Mixing lossy and perfect fifo channels. In Franck van Breugel and Marsha Chechik, editors, *Proceedings of the 19th International Conference on Concurrency Theory (CONCUR'08)*, volume 5201 of *Lecture Notes in Computer Science*, pages 340–355, Toronto, Canada, August 2008. Springer.

[5] Alain Finkel. Reduction and covering of infinite reachability trees. *Information and Computation*, 89(2) :144–179, 1990.

[6] Alain Finkel and Jean Goubault-Larrecq. Forward analysis for WSTS, part II : Complete WSTS. *Logical Methods in Computer Science*, 8(3 :28), September 2012.

[7] Alain Finkel and Louis Rosier. A survey on the decidability questions for classes of FIFO nets. In Grzegorz Rozenberg, editor, *Advances in Petri Nets 1988, Selected Papers from the 8th International Conference on Applications and Theory of Petri Nets (APN'87)*, volume 340 of *Lecture Notes in Computer Science*, pages 106–132, Zaragoza, Spain, 1988. Springer-Verlag.

[8] Alain Finkel and Philippe Schnoebelen. Well-structured transition systems everywhere ! *Theoretical Computer Science*, 256(1-2) :63–92, April 2001.

[9] Petr Jančar, Prateek Karandikar, and Philippe Schnoebelen. Unidirectional channel systems can be tested. In Jos Baeten, Tom Ball, and Frank de Boer, editors, *Proceedings of the 7th IFIP International Conference on Theoretical Computer Science (TCS'12)*, volume 7604 of *Lecture Notes in Computer Science*, pages 149–163, Amsterdam, The Netherlands, September 2012. Springer.

[10] Thierry Jéron and Claude Jard. Testing for unboundedness of FIFO channels. *Theor. Comput. Sci.*, 113(1) :93–117, 1993.

[11] Richard M. Karp and Raymond E. Miller. Parallel program schemata. *Journal of Computer and System Sciences*, 3(2) :147–195, 1969.