Exploiting concurrency in contextual Petri nets

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Abstract: Petri nets model concurrent, distributed systems. They explicitly express notions such as concurrency, causality, independence etc.

The unfolding of a Petri net is, loosely speaking, an acyclic version of the net in which the loops have been unrolled. While in general infinite, one can construct a finite portion of it that completely represents the behaviour of the system, and whose acyclic nature makes it easier to analyze. The resulting object is typically larger than the net, but much smaller than the number of its reachable markings; loosely speaking, the more concurrency there is in a Petri net, the more effcient the unfolding technique becomes in comparison to the brute-force approach of exploring all reachable markings.

However, Petri nets are not well-suited to model concurrent read accesses to the same resource, that is, if multiple actions at the same time require non-exclusive access to one common resource. Consequently, the unfolding technique becomes inefficient in the presence of such situations.

Contextual nets, which explicitly do model concurrent read accesses, address this problem. They have been used, e.g., to model concurrent database access, concurrent constraint programs, priorities, and asynchronous circuits. Their accurate representation of concurrency makes contextual unfoldings up to exponentially smaller in the presence of multiple readers. Procedures for constructing and analyzing these unfoldings therefore pave the way to better algorithms in verification and diagnosis.

We have implemented a first tool for computing these unfoldings, and we want to improve it further. The goal of an internship would be to shed light on the underlying theory, with a view to developing more efficient algorithms, which would then be implemented and tested within the existing tool. We will be happy to discuss details with interested candidates.

References:

[1] P. Baldan, A. Corradini, B. Knig and S. Schwoon. *McMillan's Complete Prefix for Contextual Nets.* In Transactions on Petri Nets and Other Models of Concurrency I, pages 199-220. Springer-Verlag, 2008.

[2] The contextual unfolding tool:
    http://www.lsv.ens-cachan.fr/~rodrigue/tools/cunf/