Title
A refined Karp and Miller tree for Petri nets

Supervisors
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Subject

General Context

Model-checking counter machines, and in particular vector additions system with states (VASS) or Petri nets, is a notoriously difficult problem. These systems are central in many modelization paradigms. This has led to the development of a number of verification tools capable of analyzing counter machines. The analysis usually proceeds through the computation of under-approximations or upper-approximations of the reachability set (or both). Under-approximations are typically obtained by an iterative fix-point computation of the reachability set, starting from the initial configuration. Upper-approximations based on downward-closed sets are computed by tools implementing the classical Karp & Miller algorithm. Some techniques, for instance abstraction-refinement and learning, combine both approximations.

Even though the reachability problem is decidable for VASS, these tools may fail to answer reachability questions on VASS, due to diverging computations or imprecise approximations.

The Karp and Miller algorithm [1] provides a simple way for deciding the coverability problem (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). This algorithm logs a state space exploration of the reachability set with a finite tree. In order to enforce the termination of this algorithm, some reachable configurations are abstracted away by replacing integral components with a special symbol ∞, which intuitively denotes a very large number. Whereas this abstraction is fine for computing the finite set of maximal elements of the limits of the reachability set, allowing to decide the coverability problem, it is no longer
sufficient for deciding the reachability problem. In order to overcome this limitation, the preciseness of this algorithm must be improved. The way we would like to explore consists in replacing the previous abstraction with a finer one. Inspired by the class of asymptotically definable sets [2] we are interested in equipping reachable markings with (1) a conic set definable in $FO(\mathbb{Q}, +, \leq, 0)$ denoting asymptotic directions of reachable markings, and (2) an additive group of $(\mathbb{Z}^d, +)$ of the form $\mathbb{Z}\vec{v}_1 + \cdots + \mathbb{Z}\vec{v}_k$ denoting periodicities of reachable markings.

This task is devoted to the problem of modifying the Karp and Miller tree construction in such a way that the termination is still guaranteed and a precise enough over approximation of the reachability set can be deduced. As an intermediate result, based on the dimension of the asymptotic definable sets, we are interested in characterizing the minimal number of counters in order to simplify VASS by removing redundant counters.

Remarks

This internship of Master 2 will be supervised in Cachan or in Bordeaux or in both places.

Qualifications

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.

Références
