Master subject

Title: Well Structured Counters and Fifo Machines

Supervisors

[Alain Finkel]
Email: alain.finkel@ens-paris-saclay.fr
Laboratoire Méthodes et Formelles
Ecole Normale Supérieure Paris-Saclay
4, avenue des Sciences
91190 Gif-sur-Yvette, France

[Georg Zetzsche]
Email: georg@mpi-sws.org
Max Planck Institute for Software Systems
Paul-Ehrlich Strasse G 26
67663 Kaiserslautern, Germany

Key words

Infinite-state systems, verification, decidability, algorithmics, logic, well structured transition systems, counter machines and fifo machines

General Context

The theory of Well Structured Transition Systems (WSTS) allows the automatic verification of infinite-state systems, that can be finitely represented and tested [1, 4, 3]. Termination, boundedness and coverability are decidable for WSTS. For complete WSTS [3], the Karp and Miller algorithm [6, 3] computes the finite set of maximal elements of the downward closure of the reachability set. This algorithm allows to decide safety and liveness problems.

Counter and Fifo automata are powerful models since they allow to simulate the tape of Turing machines. Various decidable subclasses of counter machines have been studied and the canonical well structured class of counter machines is the class of VASS (but there exist well structured counter machines which are not VASS). On the other hand, we don’t know what could be the canonical class of well structured fifo machines.

We propose the study of well structured counter and fifo machines in two ways: study the decidability of the property to be well structured for
general counter and fifo machines for a decidable ordering (which is given as an input or must be found, if it exists). Given an ordering definable in a decidable logic, characterize the well structured classes of counter and fifo machines.

Objectives

1. Recently, we have proved that given a counter machine $M$ and an ordering $\leq$ definable in the Presburger logics, one may decide whether $(M, \leq)$ is a WSTS \cite{5}. We proposed in \cite{2} to study the decidability status of the following question: given a counter machine $M$, does there exist a Presburger ordering $\leq$ such that $(M, \leq)$ is a WSTS?

2. Study the decidable logic $L$ over words such that given a fifo machine $M$ and an ordering $\leq$ definable in $L$, one may decide whether $(M, \leq)$ is WSTS.

3. Given a decidable logic $L$ over numbers or words, characterize the well-quasi orderings definable in $L$. For example: Describe the well-quasi orderings definable in Presburger arithmetic.

4. Characterize the class of fifo machines which are WSTS for the subword ordering (resp. the prefix ordering).

Location

This internship will be supervised at the Ecole Normale Supérieure Paris-Saclay and at the Max Planck Institute for Software Systems.

Qualifications and Connections

This internship is opened to strongly motivated and excellent Bachelor or Master students who like discrete mathematics, theoretical computer science and algorithmics.

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.
References


