Third PROCOPE Meeting
Aachen - Rennes

Aachen, May 29–30, 2006

Programme

Monday, May 29

9^{15} – 9^{30}		*Opening*
9^{30} – 10^{15}	**Didier Caucal** IRISA Rennes	*Synchronization of pushdown automata*
10^{15} – 10^{45}	**Coffee**	
10^{45} – 11^{30}	**Philipp Stephan** RWTH Aachen	*Deterministic visibly pushdown automata over infinite words*
11^{30} – 12^{15}	**Arnaud Carayol** IRISA Rennes	*First-order theory of rational trees*
12^{15} – 14^{00}	**Lunch**	
14^{00} –14^{45}	**Javier Esparza** University of Stuttgart	*Solving fixpoint equations in omega-continuous semirings: Some ideas and many questions*
15^{00} –15^{45}	**Markus Lohrey** University of Stuttgart	*Monadic chain logic over iterations and applications to pushdown systems*
15^{45} – 16^{15}	**Coffee**	
16^{15} – 17^{00}	**Vince Bárány** RWTH Aachen	*A hierarchy of automatic words having a decidable MSO theory*

Tuesday, May 30

10^{00} – 10^{45}	**Thomas Colcombet** IRISA Rennes	*Rabin without Mc Naughton*
10^{45} – 11^{15}	**Coffee**	
11^{15} – 12^{00}	**Pierre Wolper** University of Liège	*On the Use of Automata for Representing Arithmetic Constraints*
12^{00} – 14^{00}	**Lunch**	
14^{00} –14^{45}	**Bernard Boigelot** University of Liège	*The Power of Hybrid Acceleration*
15^{00} –15^{45}	**Jan Altenbernd** RWTH Aachen	*Tagged rewriting systems*

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Abstracts

Jan Altenbernd: *Tagged rewriting systems*

Abstract: We define a generalisation of mixed prefix/suffix rewriting systems on words by introducing special symbols (*tags* or *markers*) to mark positions in words where rewriting can occur. Typically, a rewriting rule can transform a word $w = w_0\#_1 w_1 \cdots \#_n w_n$ into a word $w' = w'_0\#_1 w'_1 \cdots \#_n w'_n$ with $w_i = w'_i$ for all i except for some i_0 where w'_{i_0} is obtained from w_{i_0} by a prefix, suffix, or complete rewriting rule $U \to V$ with regular sets U, V. Thus, arbitrary concatenations of words can be rewritten independently, substantially extending a case recently studied by Karhumäki, Kunc, and Okhotin. We study derivability issues in this setting and several variants where markers may be removed, renamed, or added in the rewriting process. We show that the derivation relation is rational in the basic case mentioned above, where markers are always preserved, while this fails in general for the other cases mentioned above. However, regularity of languages is preserved by such relations even in the case where markers can be removed.

Vince Bárány: *A hierarchy of automatic words having a decidable MSO theory*

Abstract: We investigate automatic presentations of infinite words. Starting points of our study are the works of Rigo and Maes, and Carton and Thomas concerning the lexicographic presentation, respectively the decidability of the MSO theory of morphic words. Refining their techniques we observe that the natural lexicographic presentation of a (morphic) word is canonical in a certain sense. We then go on to generalize our techniques to a hierarchy of classes of infinite words enjoying the above mentioned properties. We introduce k-lexicographic presentations, and morphisms of level k stacks and show that these are inter-translatable, and thus give rise to the same classes of k-lexicographic or level k morphic words. We prove that these presentations are also canonical, which implies decidability of the MSO theory of every k-lexicographic word as well as closure of these classes under restricted MSO interpretations, e.g. closure under deterministic sequential mappings. The classes of k-lexicographic words are shown to form a strictly increasing infinite hierarchy.

Bernard Boigelot: *The Power of Hybrid Acceleration*

Abstract: This talk addresses the problem of computing symbolically the set of reachable configurations of a linear hybrid automaton. A solution proposed in earlier work consists in exploring the reachable configurations using an acceleration

operator for computing the iterated effect of selected control cycles. Unfortunately, this method imposes a periodicity requirement on the data transformations labeling these cycles, that is not always satisfied in practice. This happens in particular with the important subclass of timed automata, even though it is known that the paths of such automata have a periodic behavior.
The goal of this work is to broaden substantially the applicability of hybrid acceleration. This is done by introducing powerful reduction rules, aimed at translating hybrid data transformations into equivalent ones that satisfy the periodicity criterion. In particular, we show that these rules always succeed in the case of timed automata. This makes it possible to compute an exact symbolic representation of the set of reachable configurations of a linear hybrid automaton, with a guarantee of termination over the subclass of timed automata. Compared to other known solutions to this problem, our method is simpler, and applicable to a much larger class of systems.
(joint work with Frédéric Herbreteau, LaBRI)

Arnaud Carayol: *First-order theory of rational trees*

Abstract: Rational graphs are a family of graphs defined using labelled rational transducers. Unlike automatic graphs (defined using synchronized transducers) the first order theory of these graphs is undecidable. In this talk we consider the family of rational trees (rational graphs which are trees) and we show that the first order theory is decidable for this family. We will also present counter examples showing that this result cannot be significantly extended both in terms of logic and of structure.
This is a joint work with Christophe Morvan.

Didier Caucal: *Synchronization of pushdown automata*

Abstract: We introduce the synchronization of a pushdown automaton by a sequential transducer associating an integer to each input word. The visibly pushdown automata are the automata synchronized by an one state transducer whose output labels are $-1, 0, 1$. For each transducer, we can decide whether a pushdown automaton is synchronized. The pushdown automata synchronized by a given transducer accept languages which form an effective boolean algebra containing the regular languages and included in the deterministic real-time context-free languages.

Thomas Colcombet: *Rabin without Mc Naughton*

Abstract: Standard proofs of the Rabin complementation lemma make use of two key ingredients: positional determinacy in parity games and determinisation of automata over infinite words (i.e. Mc Naughton's theorem).
We consider here a proof approach which does not make use of any determinisation result. The outcome of the construction is an automaton which is, by construction, using a parity acceptance condition. This fact gives a new insight on the meaning of parity condition.

Javier Esparza: *Solving fixpoint equations in omega-continuous semirings: Some ideas and many questions*

Abstract: I'll introduce monotonic systems of equations in omega-continuous semirings. After some motivation, I'll consider the problem of finding iteration schemes for the solution. I'll present some known results for particular cases, one or two small new results, and many open questions.
This is work in progress with Stefan Kiefer and Michael Luttenberger.

Markus Lohrey: *Monadic chain logic over iterations and applications to pushdown systems*

Abstract: The investigation of the logical properties of iterations (or tree-like unfoldings) of relational structures goes back to work of Shelah, Stupp, and others. A famous theorem of Muchnik states that the monadic second-order theory of the iteration of a structure can be reduced to the monadic second-order theory of the structure itself. In Muchnik's unfolding the so called clone-predicate, which allows to relate different levels in the tree-like unfolding, plays a crucial role. In this talk, we will sketch a proof for a kind of first-order version of Muchnik's theorem. More precisely, we show that the monadic chain theory of the tree-like unfolding without the clone predicate can be reduced to the first-order theory of the base structure. Monadic chain logic is the fragment of full monadic second-order logic (and the extension of first-order logic), where second-order variables are restricted to chains (linearly ordered subsets) of the tree structure of the iteration. We also show that our first-order variant of Muchnik's theorem fails, if we include the clone-predicate. We finally apply our results to first-order logic with regular reachability predicates (FOREG) over a model of pushdown systems, where the finite stack alphabet is replaced by an infinite relational structure.
(joint work with Dietrich Kuske, University of Leipzig)

Philipp Stephan: *Deterministic visibly pushdown automata over infinite words*

Abstract: The stack operation of a visibly pushdown automaton (VPA) is determined by the input letter. This restriction results in improved closure properties compared to general pushdown automata. However, visibly pushdown automata over infinite words are still not determinizable. The concept of stair visibly pushdown automata (StVPA) resolves this weakness. StVPA evaluate the acceptance condition only on those states which occurred within a configuration, such that the stack height is greater or equal at all future configurations.
In this talk we compare and analyze the classes of deterministic VPA and StVPA equipped with a parity condition.

Pierre Wolper: *On the Use of Automata for Representing Arithmetic Constraints*

Abstract: This talk presents a survey of automata-based techniques for representing and manipulating linear arithmetic constraints. After introducing the basic concepts used in this approach, both representing integer constraints by finite-word automata and real constraints by infinite-word automata is discussed. Various results about the construction of automata from constraints and about the specific

properties of automata representing arithmetic constraints are then presented. Finally, the problems of computing the limit of a sequence of arithmetic automata and of computing formulas from automata are briefly considered.