Research Internship – Master M2 (2016/2017)

Location : Laboratoire Spécification et Vérification (LSV)
Ecole Normale Suprieure Paris-Saclay

Title : Temporal logics on strings

Advisor : Stéphane Demri (LSV, CNRS, ENS Paris-Saclay)
demri@lsv.fr

String theories in a temporal setting. Reasoning about strings is increasingly required in program verification and recently much effort has been dedicated toward designing solvers that handle string theories, see e.g. [AAC$^+$14, HL14]. The decidability status of expressive string theories is not always known, see e.g. [LRT$^+$14, Section 2.1] or [AAC$^+$14], but fortunately, decidability of word equations is known to be decidable thanks to Makanin's result [Mak77] and a PSPACE algorithm has been designed by Plandowski in [Pla04]. Many works have been dedicated to reasoning about temporal logics on concrete domains, see e.g. [BGL12, DHV14], so that temporal reasoning is done about the evolution of typed variables (for instance interpreted by integers or by strings to cite a few examples). Even when decidability is preserved, the complexity can be relatively high. For instance, LTL over the concrete domain $(\mathbb{N}, \leq)$ is PSPACE-complete [DD07, DG08]. In this internship, we are interested in temporal logics (see e.g. [DGL16]) when the concrete domain contains finite strings.

Temporal logics on strings with the prefix relation. A remarkable breakthrough has been made recently in [CKL13] by showing that CTL* over the domain $(\mathbb{N}, \leq)$ is decidable by using the decidability of Boolean combinations of formulae from MSO and from WMSO+U [BT12] where U is the unbounding second-order quantifier (see also the follow-up work [CKL14] involving ECTL*). Unfortunately, none of the known techniques has been able to handle LTL over concrete domain of the form $(\Sigma^*, \preceq)$ where $\preceq$ is not a total ordering on Σ^* such as the prefix relation $\preceq_p$ or the subword relation $\sqsubseteq$. In the paper [DD16], the main result establishes that the satisfiability problem for LTL over $(\Sigma^*, \preceq)$ is decidable and PSPACE-complete, which is done by an approach that consists in translating prefix constraints into numerical constraints.

Objectives of the research internship

(1) To become familiar with the works and techniques from [CKL13, DD16] with the goal to extend results from [DD16].

(2) To study how the method of transforming string constraints into numerical constraints can be extended, for instance by allowing in the concrete domain the prefix relation and the suffix relation.

(3) If time permits, to characterize the computational complexity for known decidable temporal logics for which the question is open.

This research internship may be pursued as a PhD thesis, whose subject may vary according to the candidate's research interests.

Related courses at MPRI:

For your information, the following MPRI courses are related to this research internship. Students from other master programmes are welcomed to apply too.

- Course 1.22 *Basics of Verification*
- Course 2.5.1 *Automated Deduction*
- Course 2.9.1 *Mathematical foundations of the theory of infinite transition systems*

References

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