Constraints for membership in formal languages under systematic search and stochastic local search

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Abstract

This thesis focuses on constraints for membership in formal languages under both the systematic search and stochastic local search approaches to constraint programming (CP). Such constraints are very useful in CP for the following three reasons: They provide a powerful tool for user-level extensibility of CP languages. They are very useful for modelling complex work shift regulation constraints, which exist in many shift scheduling problems. In the analysis, testing, and verification of string-manipulating programs, string constraints often arise. We show in this thesis that CP solvers with constraints for membership in formal languages are much more suitable than existing solvers used in tools that have to solve string constraints. In the stochastic local search approach to CP, we make the following two contributions: We introduce a stochastic method of maintaining violations for the regular constraint and extend our method to the automaton constraint with counters. To improve the usage of constraints for which there exists no known constant-time algorithm for neighbour evaluation, we introduce a framework of using solution neighbourhoods, and give an efficient algorithm of constructing a solution neighbourhood for the regular constraint. In the systematic search approach to CP, we make the following two contributions: We show that there may be unwanted consequences when using a propagator that may underestimate a cost of a soft constraint, as the propagator may guide the search to incorrect (non-optimum) solutions to an over-constrained problem. We introduce and compare several propagators that compute correctly the cost of the edit-distance based soft-regular constraint. We show that the context-free grammar constraint is useful and introduce an improved propagator for it.

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