Hybrid Core-based and Branch-and-Bound algorithms for Weighted Constraint Satisfaction

Topics : Combinatorial Optimization
Host team : Statistiques et Algorithmique pour la Biologie (SaAB)
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Renumeration : $\approx$ 550 euros / mo

Introduction. The current state of the art in exact solving of Weighted Constraint Satisfaction Problems (WCSPs) is based on branch and bound. The efficiency of such procedures is founded on the efficient computation of strong lower bounds during search [CdGS+10]. In the related field of maximum satisfiability (MaxSAT), a different strand of research has emerged, in which tree search only tests for satisfiability, while bound computation is delegated either to a Integer Linear Programming solver (implicit hitting set [DB11]) or to ad-hoc techniques (core-guided [MDM14, NB14]), which we collectively call core-based. However, these techniques do not have the same success in WCSP.
It has recently been proposed that, with some adaptations specific to WCSP, MaxSAT-inspired algorithms like implicit hitting set can be successful in WCSP too [DB13, LMR24]. These take advantage of the specific structure offered by the decomposition of WCSP into individual cost functions. This research opens the way to deeper integration between branch-and-bound methods and implicit hitting set or core-guided methods for solving WCSP.

Content of the Internship. In this internship, we will develop new hybrid solvers, borrowing ideas from both branch-and-bound and core-based algorithms. We will explore various algorithmic designs aimed at achieving different tradeoffs in satisfaction versus optimization in core computation. These algorithms will take advantage of two facts: first, by performing partial optimization with branch-and-bound during core discovery, we can discover smaller, therefore more useful, cores for core-based algorithms; second, we can export the results of bound computation from core-based algorithms back to branch-and-bound, making for a more efficient search. The result should be a hybrid algorithm which performs better than an oracle than selects the best among the base algorithms.
The internship will work with the Toulbar2 solver [HOA+16] developed by members of the MIAT team, as well as various SAT solvers and ILP solvers. It will require coding the new algorithms either through the Python interface of Toulbar2 or directly in C++. The evaluation of the efficacy of the algorithms will require conducting extensive experiments on clusters.
There exists funding for a potential continuation of the internship to a PhD.

References

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