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Berg, Jeremias

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# Loandra: Core-Boosted Linear Search Entering MaxSAT Evaluation 2019

Jeremias Berg\*, Emir Demirović†, Peter Stuckey†‡

\*HIIT, Department of Computer Science, University of Helsinki, Finland

†University of Melbourne, Australia

‡Data61, CSIRO, Australia

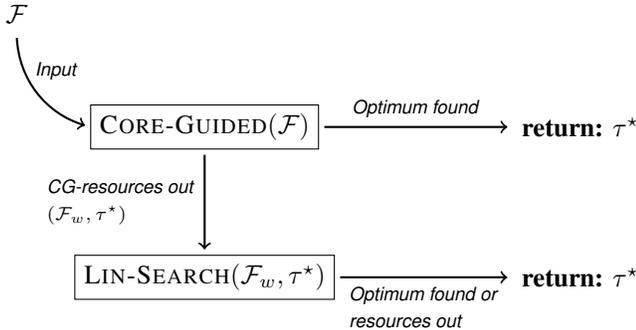


Fig. 1: The structure of Loandra.

## I. PRELIMINARIES

We briefly overview the Loandra MaxSAT-solver as it participated in the incomplete track of the 2019 MaxSAT Evaluation. A more thorough discussion can be found in [4]. We assume familiarity with conjunctive normal form (CNF) formulas and weighted partial maximum satisfiability (MaxSAT). Treating a CNF formula as a set of clauses a MaxSAT instance  $\mathcal{F}$  consists of two CNF formulas, the hard clauses  $F_h$  and the soft clauses  $F_s$ , as well a weight  $w_c$  associated with each  $C \in F_s$ . A solution to  $\mathcal{F}$  is an assignment  $\tau$  that satisfies  $F_h$ . The cost of a solution  $\tau$  is the sum of weights of the soft clauses falsified by  $\tau$ . An optimal solution is one with minimum cost over all solutions. An unsatisfiable core  $\kappa$  of  $\mathcal{F}$  is a subset of soft clauses s.t.  $F_h \wedge \kappa$  is unsatisfiable.

## II. CORE-BOOSTED LINEAR SEARCH

Loandra consists of two main components: CORE-GUIDED, a core-guided reformulation algorithm extended with stratification [1], and LIN-SEARCH, a SAT/UNSAT linear search algorithm. Both components make extensive use of Boolean Satisfiability (SAT) solvers. On input  $\mathcal{F}$ , CORE-GUIDED searches for an optimal MaxSAT solution by iteratively extracting unsatisfiable cores with a SAT solver and modifying a working instance (initialised to  $\mathcal{F}$ ) in order to rule out them as sources of unsatisfiability. LIN-SEARCH iteratively queries the SAT solver for a solution of lower cost than the currently best known one. Both components are *complete*, i.e. given enough time and memory, both will compute an optimal solution. More importantly for the incomplete track, they also are *any-time*, i.e. both can output intermediate solutions during

search. Note that stratification allows treating CORE-GUIDED as an any-time algorithm.

Figure 1 overviews the structure of Loandra. It uses core-boosting as described in [4] in order to exploit the strengths and alleviate the weaknesses of its individual components. On input  $\mathcal{F}$  Loandra starts in a core-guided phase by invoking CORE-GUIDED on  $\mathcal{F}$ . If the optimal solution isn't found within the time allocated to the core-guided phase, the execution switches to a linear phase and LIN-SEARCH is invoked with  $\tau^*$ , the best solution found by the core-guided phase, and  $\mathcal{F}_w$ , the final working instance of CORE-GUIDED. The linear search runs until either finding the optimal solution or reaching the time out, at which point the currently best known solution is returned.

## III. IMPLEMENTATION DETAILS

The version of Loandra that entered the 2019 Evaluation is the same one as was experimented on in [4]. As the instantiation of CORE-GUIDED we use a reimplementaion of the PMRES [8] MaxSAT algorithm extended with weight aware core extraction (WCE) [5] and clause hardening. The core-guided phase runs until no more cores can be found with the stratification bound set to 1, or 30s has passed.

As the instantiation of LIN-SEARCH we use a reimplementaion of LinSBPS [3], SAT/UNSAT linear search extended with solution-based phase saving and varying resolution. Following LinSBPS we use the generalized totalizer encoding [6] to convert the PB constraints needed in linear search to CNF. All algorithms are implemented on top of the publicly available Open-WBO system [7] using Glucose 4.1 [2] as the back-end SAT solver.

## IV. COMPILATION AND USAGE

Building and using Loandra resembles building and using Open-WBO. A statically linked version of Loandra in release mode can be built by running `MAKE RS` in the base folder.

After building, Loandra can be invoked from the terminal. Except for the formula file, Loandra accepts a number of command line arguments: the flag `-pmreslin-cglim` sets the maximum time that the core-guided phase can run for (in seconds). The rest of the flags resemble the flags accepted by Open-WBO; invoke `./loandra_static -help-verb` for more information.

## REFERENCES

- [1] C. Ansótegui, M. L. Bonet, J. Gabàs, and J. Levy, “Improving SAT-based weighted MaxSAT solvers,” in *Proc. CP*, ser. Lecture Notes in Computer Science, vol. 7514. Springer, 2012, pp. 86–101.
- [2] G. Audemard and L. Simon, “Predicting learnt clauses quality in modern sat solvers,” in *Proc IJCAI*. Morgan Kaufmann Publishers Inc., 2009, pp. 399–404.
- [3] F. Bacchus, M. Järvisalo, R. Martins *et al.*, “Maxsat evaluation 2018,” <https://maxsat-evaluations.github.io/2018/>, 2018, accessed: 2018-9-05.
- [4] J. Berg, E. Demirovic, and P. Stuckey, “Core-boosted linear search for incomplete maxsat,” in *Proc CPAIOR*, ser. Lecture Notes in Computer Science, vol. ????. Springer, 2019, p. ??? (to appear).
- [5] J. Berg and M. Järvisalo, “Weight-aware core extraction in SAT-based MaxSAT solving,” in *Proc. CP*, ser. Lecture Notes in Computer Science, 2017, to appear.
- [6] S. Joshi, R. Martins, and V. M. Manquinho, “Generalized totalizer encoding for pseudo-boolean constraints,” in *Proc. CP*, ser. LNCS, vol. 9255, 2015, pp. 200–209.
- [7] R. Martins, V. Manquinho, and I. Lynce, “Open-WBO: A modular MaxSAT solver,” in *Proc. SAT*, ser. Lecture Notes in Computer Science, vol. 8561. Springer, 2014, pp. 438–445.
- [8] N. Narodytska and F. Bacchus, “Maximum satisfiability using core-guided MaxSAT resolution,” in *Proc. AAAI*. AAAI Press, 2014, pp. 2717–2723.