

# LMHS in MaxSAT Evaluation 2017

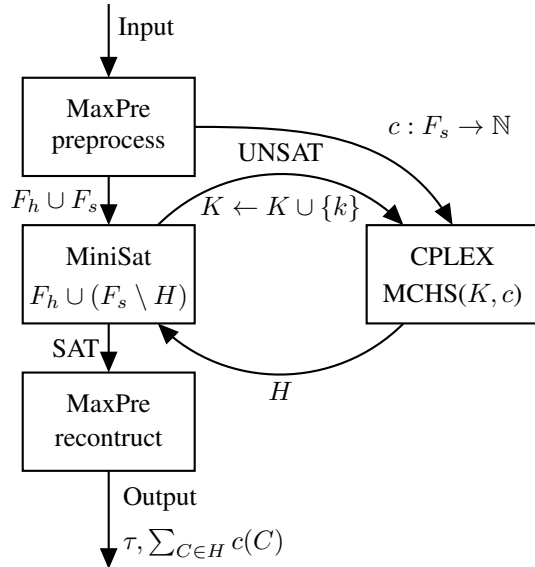
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**Abstract**—We describe recent updates to the LMHS MaxSAT solver, submitted to the 2017 MaxSAT Evaluation.

## I. INTRODUCTION

An updated version of the LMHS MaxSAT solver [1] is submitted to the 2017 MaxSAT evaluation. This version includes many incremental updates and bugfixes. Major improvements include the addition of a purpose-built MaxSAT preprocessor MaxPre, and LP-based reduced-cost fixing for forcing soft clauses during search.

## II. IMPLICIT HITTING SET ALGORITHM



LMHS implements the implicit hitting set algorithm [2] for MaxSAT [3], [4]. We apply MaxSAT preprocessing to simplify the problem before solving. After preprocessing, the MaxSAT cost function  $c$  is input to the optimizer and the CNF formula (hard clauses  $F_h$  and soft clauses  $F_s$ ) is given to the satisfiability checker. MiniSat 2.2 [5] is used as the satisfiability checker, and CPLEX 12.7 [6] as the optimizer.

In short, the implicit hitting set loop alternates between checking the satisfiability of the formula (excluding a hitting set  $H$ ) to find an unsatisfiable core  $k$ . Unsatisfiable cores are accumulated in a set  $K$ , for which the optimizer finds a minimum-cost hitting set wrt. the cost function  $c$ .

Upper bounds on the optimal solution cost (feasible solutions) are found during search LMHS's core minimization procedure and non-optimal hitting set phase (not pictured). Lower bounds are proved by the optimizer.

## III. LCNF PREPROCESSING

LMHS has been updated with a new MaxSAT preprocessor, MaxPre [7]. MaxPre implements a range of well-known and recent SAT-based preprocessing techniques as well as MaxSAT-specific techniques that make use of weights of soft clauses. MaxSAT specific techniques include group detection, label matching, group-subsumed label elimination, and binary core removal. Tight integration with MaxPre's C++ API eliminates unnecessary I/O overhead. LMHS solves the preprocessed instance directly as a labelled CNF formula [8], which avoids the addition of new auxiliary variables to soft clauses.

## IV. REDUCED-COST FIXING

We implement recent reduced-cost fixing techniques for MaxSAT [9]. LP-based reduced-cost fixing together with bounds allow for some soft clauses to be hardened or relaxed during search, simplifying the problem. This inexpensive technique requires only that the LP relaxation of the hitting set IP is solved once per iteration.

## V. INCOMPLETE TRACK

New for 2017 we also submit LMHS to the incomplete track. The large number of feasible solutions found during search means that LMHS can provide a solution at any point during the search, after verifying that one exists.

## VI. AVAILABILITY

LMHS is open source and available at <https://www.cs.helsinki.fi/group/coreo/lmhs/>. MaxPre is available as a standalone preprocessor at <https://www.cs.helsinki.fi/group/coreo/maxpre/>.

## REFERENCES

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