

# Pacose: An Iterative SAT-based MaxSAT Solver

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## I. OVERVIEW

Pacose is a SAT-based MaxSAT solver, using two incremental CNF encodings, a binary adder [1] and the Dynamic Polynomial Watchdog (DPW) [2], for Pseudo-Boolean (PB) constraints. It is an extension of QMaxSAT 2017 [3], based on Glucose 4.2.1 [4] SAT solver. It uses a Boolean Multilevel Optimization (BMO) pre- / inprocessing method to simplify the instances. Additionally a trimming method is applied to cut off unsatisfiable soft clauses and find a good initial satisfiable weight to reduce the size of the encoding.

## II. PRE- / INPROCESSING

The 2023 version of Pacose contains the preprocessing tool maxpre version 2 [5] and performs our own preprocessing routines Generalized Boolean Multilevel Optimization (GBMO) and TrimMaxSAT [6].

MaxPre version 1 [7], has already been utilized by several MaxSAT solvers in past competitions. Preprocessing has gained increasing importance in recent years, with many top solvers from previous years adopting MaxPre and other techniques to achieve favorable results. The successful outcomes reported in [5] have further persuaded us to incorporate version 2 of this preprocessor into our own implementation.

We generalized the plain variant of Boolean Multilevel Optimization to work with arbitrary weights and split additional instances with that. Further we implemented a greedy algorithm TrimMaxSAT to remove never satisfiable instances and getting first upper / lower bounds.

## III. ENCODING AND ALGORITHM

Our DPW encoding is based on the Polynomial Watchdog (PW) encoding [8], which uses totalizer networks [9]. Essentially the DPW encoding employs multiple totalizer networks to perform a binary addition with carry on the sorted outputs. A special algorithm to solve these instances incremental is presented in [2].

Additionally the adder network [1] is used which has a linear complexity in encoding size in contrast to at least  $\mathcal{O}(n^2)$  for the DPW sorting network. With the adder network many complementary instances to the DPW encoding can be solved and therefore it is well suited, to be chosen, together with DPW by a heuristic, as described in the following chapter. The algorithm and encoding are partly adapted and inspired from QMaxSAT.

## IV. HEURISTICS

Pacose uses straightforward heuristics based on available MaxSAT benchmarks. All heuristics are based on the number of soft clauses and the overall sum of soft weights.

- *Encoding*: The DPW encoding empirically works best if the average weight for soft clauses is small, or the overall sum of soft weights is huge (bigger than 80 billion). For other instances the binary adder is chosen.
- *Trimming*: As for instances with only a few soft clauses the trimming preprocessing algorithm is not effective, it is only used if the benchmark contains at least a certain amount of soft clauses.
- *Compression Rate*: For benchmarks with only a few soft clauses, the encoding is smaller and additional clauses can be added. Therefore, the binary adder encoding can solve overall more benchmarks if the compression rate is chosen accordingly.

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