

# CASHWMaxSAT: Solver Description

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**Abstract**—This document describes the MaxSAT solver CASHWMaxSAT, submitted to the complete tracks(include unweighted and weighted track) of MaxSAT Evaluation 2021.

## I. INTRODUCTION

CASHWMaxSAT is a complete MaxSAT solver. It is developed from UWMaxSat [1]. Same with UWMaxSat, CASHWMaxSAT also applies an unsatisfiable-core-based OLL procedure [2]–[4] and uses the same constraint encoding method.

We’ve made four improvements based on UWMaxSat. The first one is that we transform the maxsat problem to an Integer Programming(IP) problem and use an IP solver to solve it on both unweighted and weighted cases. The other three improvements are related to OLL procedure, and only used on unweighted cases, details will be discussed in chapter II.

CASHWMaxSAT utilizes COMiniSatPS [5] as its SAT solver and SCIP-7.0.2 [6], [7] as its IP solver.

## II. DESCRIPTION

### A. Utilizing an IP solver

For small-scale maxsat problem(number of variables and clauses are relatively small), we transform the maxsat problem to an IP problem, then use an IP solver to solve it in a limited time. The process detail is as following,

- 1) extract AtMost1 constraints from soft clauses, exactly same as UWMaxSat
- 2) transform every clause(include hard and soft) to a constraint and add it to the IP solver
- 3) IP solver starts solving, if optimal is found, output the best solution and exit the program. Otherwise, if reaching the limited time, switch to OLL procedure

The difficulty of solving maxsat problem by OLL procedure is about increasing lower bound(LB), i.e. looking for an unsatisfiable-core by SAT solver. But IP solver could use many different algorithm(branch and bound, cutting plane, simplex, etc.) to increase LB. The idea using an IP solver is inspired by MaxHS [8].

### B. MultiSolve strategy

If an unsatisfiable-core is obtained, there maybe existing more unsatisfiable-cores. As EvalMaxSAT [9] indicates, the size of the unsatisfiable-core plays an important role in the performance of OLL procedure. So we call sat solver multiple

times and pick the smallest unsatisfiable-core. This strategy is inspired by EvalMaxSAT.

### C. DynamicDelay strategy

In UWMaxSat, when an unsatisfiable-core is obtained and minimized, new constraint will be encoded immediately, the variables in the unsatisfiable-core will be removed from assumptions, and the relax variable created by encoding step will be added to assumptions immediately. On the contrary, new constraint will not be encoded immediately in EvalMaxSAT.

In practice, whether delaying to encode the new constraint and add new-created relax to assumption has a big impact on OLL procedure. So we propose the DynamicDelay strategy: if the size of unsatisfiable-core is more than a predefined threshold, delaying strategy is used.

### D. DelayPopOne strategy

If DynamicDelay strategy is used, when the formula becomes satisfiable, delayed relax variables will be added to assumption. We could choose adding all or only adding one. By experiments, adding one will let the problem be easy to be solved.

## III. FUTURE WORK

Firstly, we could try using satlike [10], [11] to get a feasible solution and add it to IP solver’s solution pool.

Secondly, we could try using sat-solver to get some unsatisfiable-cores and transform every unsatisfiable-core to a constraint, then add it to IP solver.

Finally, we could try using MultiSolve strategy, DynamicDelay strategy, DelayPopOne strategy on weighted cases.

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