

NuWLS-c-2023: Solver Description

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Abstract—This document serves as a description of our solver, NuWLS-c-2023, which has been submitted to all four incomplete tracks of the MaxSAT Evaluation 2023.

I. INTRODUCTION

Our NuWLS-c-2023 solver is an improved version of the NuWLS-c solver that participated in the MaxSAT Evaluation 2022. Like SATLike-c [1], [2], NuWLS-c-2023 includes two engines - one is our proposed stochastic local search (SLS) algorithm NuWLS-2.0, which introduces a new weighting scheme for soft and hard constraints; the other is the SAT-based algorithm TT-Open-WBO-Inc [3].

II. THE SLS ALGORITHM: NUWLS-2.0

A. Preliminaries

For each clause c , we use $w(c)$ to denote the weight of clause c . For each soft clause c , we use $w_{org}(c)$ to denote the original weight of c , which is given in the instance. avg_{softw} is used to denote the average original soft clause weights. It is evident that for unweighted instances, the values of $w_{org}(c)$ and avg_{softw} are always equal to 1.

B. The New Weighting Scheme

In the literature [4], it is noted that developing a weighting scheme for problems with hard constraints is challenging as it involves weighing unsatisfied constraints while preserving the differentiation between hard and soft constraints. To balance the relationships between hard and soft clause weights, we designed the following weighting scheme, named **New-Weighting**.

At the beginning of each round of the local search process, the New-Weighting scheme initializes each clause weight as follows:

- For each hard clause c , we set $w(c) := 1$.
- For each soft clause c , we set $w(c) := n \times 1$ for unweighted instances, and $w(c) := n \times \frac{w_{org}(c)}{avg_{softw}}$ for weighted instances, where n is initialized to 0.

When the local search encounters a local optimum, the clause weights are updated as follows:

- For hard clauses: for each falsified hard clause c , $w(c) := w(c) + h_inc$.
- For soft clauses: if the current assignment α is a feasible solution, then $n := n + s_inc$.

n is a coefficient dynamically adjusted in the weighting scheme to control the weights of soft clauses. h_inc is the

increment for hard clause weight. s_inc is the increment for the coefficient n .

Algorithm 1: NuWLS-2.0

Input: (W)PMS instance F , $cutoff$.

Output: The best solution found and its $cost$, or “No solution found”.

$\alpha^* := \emptyset$; $cost^* := +\infty$;

while $elapsed\ time < cutoff$ **do**

$\alpha :=$ an initial complete assignment;

 Initialize clause weights by **New-Weighting**;

$L = 10000000$;

for $step = 0$; $step < L$; $step++$ **do**

if α is feasible **and** $cost^* > cost(\alpha)$ **then**

$\alpha^* := \alpha$; $cost^* := cost(\alpha)$; $L = step + 10000000$;

if $cost^* == 0$ **then**

return α^* and $cost^*$;

if $(D = \{x | score(x) > 0\}) \neq \emptyset$ **then**

$v :=$ a variable in D selected by BMS strategy;

else

 update clause weights by **New-Weighting**;

if \exists falsified hard clauses **then**

$c :=$ a random falsified hard clause;

else

$c :=$ a random falsified soft clause;

$v :=$ the variable with highest score in c ;

$\alpha := \alpha$ with v flipped;

if $\alpha^* \neq \emptyset$ **then return** α^* and $cost^*$;

else return No solution found;

Our weighting scheme treats all soft clauses as a single constraint, and it exhibits several novel features. First, previous weighting schemes for (weighted) partial MaxSAT ((W)PMS) problem either did not change the weights of soft clauses, or treated them the same as hard clauses by increasing the weight of unsatisfied soft clauses or decreasing the weight of satisfied soft clauses. Our weighting scheme increases the weights of all soft clauses equally, regardless of whether they are satisfied or not. Second, our weighting scheme eliminates the need for setting upper bounds on the weights of soft clauses (Weighting-PMS [5]). Instead, it limits the increase of soft clause weights by imposing certain conditions (under the condition that the current assignment is a feasible solution). Third, this weighting scheme preserves the relative importance of weights among soft clauses in weighted instances.

C. Our NuWLS-2.0 Algorithm

Based on the **New-Weighting** scheme and the dynamic local search (DLS) framework, we develop a new SLS algorithm named NuWLS-2.0. The pseudo-code of NuWLS-2.0 is outlined in algorithm 1.

III. THE HYBRID SOLVER: NUWLS-C-2023

We combine NuWLS-2.0 with the state-of-the-art SAT-based solvers TT-Open-WBO-Inc [3], leading to the hybrid solver NuWLS-c-2023. The framework of NuWLS-c-2023 is similar to SATLike-c [1], [2].

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