NuWLS-c: Solver Description

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***Abstract*—This document describes the solver NuWLS-c, submitted to the four incomplete tracks of MaxSAT Evaluation 2022.**

I. Introduction

NuWLS-c is based on SATLike-c [3]. NuWLS-c has two main engines, one is the local search solver NuWLS and the other is the SAT-based solver TT-Open-WBO-inc [2].

II. Local Search Algorithm: NuWLS

Our NuWLS algorithm utilizes the framework of the local search algorithm SATLike [1], which is a dynamic local search framework for SAT and exploits the distinction of hard and soft clauses by a clause weighting scheme.

We propose a new clause weighting scheme for updating clause weights during the local search, which makes a deeper distinction between hard and soft clauses. The weighting scheme used in NuWLS is named **Dist-Weighting** (Distinguished Weighting).

First, usually, SLS algorithms update clause weights when encountering local optima. Nevertheless, previous clause weighting schemes either update only the hard clause weights, or update both hard and soft clause weights under the same conditions. Our Dist-Weighting scheme updates hard and soft clause weights according to different activation conditions.

Second, the framework of the SATLike algorithm uses a scoring function (the score of the variable, $score(x)$) to guide the search. $score(x)$ is the increment of the total weight of satisfied clauses (either hard clauses or soft clauses) caused by flipping x. For the weighted instances, when the weights of soft clauses are updated, the importance between soft clauses could be destroyed, thus leading the search to a region where there is no chance of finding better solutions. The issue is more pronounced when the average weight of soft clauses is small. In fact, SATLike does not increase the weights of soft clauses when solving weighted instances where the average weight of soft clauses ($ws_{avg}(I)$) is less than 10000. Additionally, too large average weight of soft clauses disrupts the balance between the hard and soft clauses. To address this issue, we propose a weighting scheme where the weight of each soft clause c ($w(c)$) is initially set to 1, and the upper limit of the soft clause weight is proportional to its original weight $w_{org}(c)$. Set a parameter s_{avg}, for an instance I whose average weight of soft clauses is $ws_{avg}(I)$, then the upper limit of the weight of each soft clause c in instance I is $\frac{s_{avg} \times w_{org}(c)}{ws_{avg}(I)} + \delta$, where δ is a parameter.

For each unweighted instances I, $ws_{avg}(I) = 1$, the weight of each soft clause in I is 1 (i.e., $w(c)$ = 1), then the upper limit of the weight of each soft clause c in I is $s_{avg} + \delta$.

Based on the above two ideas, we present our new weighting scheme. For each clause, the initial weight is set to 1. When the algorithm encounters a local optimum, the clause weights are updated as follows:

- For hard clauses: with probability h_sp and the condition that a feasible solution is found in the current round of local search, for each satisfied hard clause c, $w(c) := w(c) - h\_inc$ if $w(c) > h\_inc$; otherwise, for each falsified hard clause c, $w(c) := w(c) + h\_inc$.
- For soft clauses: the weights of soft clauses are only updated if $cost(\alpha) \geq cost(\alpha^*)$. Specifically, with probability s_sp, for each satisfied soft clause c, $w(c) := w(c)\text{-}s\_inc$ if $w(c) > s\_inc$; with probability $1 - s\_sp$, if α is feasible, then for each falsified soft clause c, $w(c) := w(c) + s\_inc$ if $w(c) < \frac{s_{avg} \times w_{org}(c)}{ws_{avg}(I)} + \delta$. (We use α to denote the current assignment, α^* is used to denote the best solution found, $cost(\alpha)$ is used to denote the sum of $w_{org}(c)$ of all the unsatisfied soft clauses under α.)

III. Hybrid Solver: NuWLS-c

We combine NuWLS with the state of the art SAT-based solvers TT-Open-WBO-inc [2], leading to the hybrid solver NuWLS-c.

The framework of NuWLS-c is similar to SATLike-c [3].

References

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