Open-WBO @ MaxSAT 2018

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I. Introduction

Open-WBO [1] is an open source MaxSAT solver that supports several MaxSAT algorithms [2], [3], [4], [5], [6], [7], [8] and MaxSAT solvers [9], [10]. Open-WBO is particularly efficient for unweighted MaxSAT and has been one of the best solvers in the MaxSAT Evaluations from 2014 to 2017. Two versions of Open-WBO were submitted to the MaxSAT Evaluation 2018 (MSE2018): OPEN-WBO-RISS and OPEN-WBO-GLUC. The remainder of this document describes the MaxSAT algorithms and SAT solvers used in each version.

II. SAT solvers

OPEN-WBO is based on the data structures of MINISAT 2.2 [9], [11]. Therefore, solvers based on MINISAT 2.2 can be used as potential backend, including formula simplification. The default SAT backend is GLUCOSE 4.1 [10], [12], which has been improved for incremental search [13]. Furthermore, formula simplification is typically disabled, as most work on incremental SAT solving with formula simplification, e.g. [14], has not been backported into MINISAT 2.2 or GLUCOSE 4.1.

Besides GLUCOSE 4.1, OPEN-WBO now supports MINISAT 2.2 and RISS [15], where MINISAT 2.2 [9] is the latest version from GitHub [11]. In this version, some data structures are different, for example the representation of the conflicting set of assumption literals. Also, the file structure changed. Both RISS and MINISAT 2.2 support reserving variables when a SAT solver is created, which allows to store them in a more compact way. Given the variety of solvers and features, we adapted OPEN-WBO to support solvers with both the old as well as the new file structure, and furthermore, allow to select whether the variable reservation feature is available during compile time. The different versions submitted to the MaxSAT Evaluation 2018 differ between themselves on the backend SAT solver. Namely, OPEN-WBO-RISS and OPEN-WBO-GLUC use RISS and GLUCOSE 4.1, respectively.

III. MaxSAT Algorithms

In this section we briefly describe the algorithms used for the complete and incomplete tracks at the MSE2018.

A. Complete Track

For the complete track, OPEN-WBO uses a variant of the unsatisfiability-based algorithm MSU3 [3] for unweighted problems and the OLL algorithm [7] for weighted instances. These algorithms work by iteratively refining a lower bound λ on the number of unsatisfied soft clauses until an optimum solution is found. Both MSU3 and OLL use the Totalizer encoding for incremental MaxSAT solving [4]. For unweighted MaxSAT, we extended the incremental MSU3 algorithm [4] with resolution-based partitioning techniques [8]. We represent a MaxSAT formula using a resolution-based graph representation and iteratively join partitions by using a proximity measure extracted from the graph representation of the formula. The algorithm ends when only one partition remains and the optimal solution is found. Since the partitioning of some MaxSAT formulas may be unfeasible or not significant, we heuristically choose to run MSU3 with or without partitions. In particular, we do not use partition-based techniques when one of the following criteria is met: (i) the formula is too large ($>$ 1,000,000 clauses), (ii) the ratio between the number of partitions and soft clauses is too high ($>$ 0.8), or (iii) the sparsity of the graph is too small ($<$ 0.04). For weighted MaxSAT, we use the OLL algorithm [7] without further improvements.

B. Incomplete Track

For the incomplete track, OPEN-WBO uses a linear search algorithm SAT-UNSAT [16] with lexicographical optimization for weighted problems [17]. This algorithm works by performing a sequence of calls to a SAT solver and refining an upper bound μ on the number of unsatisfied soft clauses. To restrict μ at each iteration, we need to encode a cardinality constraint (pseudo-Boolean constraint) for unweighted (weighted) problems into CNF. The LSU version versions uses the Modulo Totalizer encoding [18] for cardinality constraints and the Adder [19] or Generalized Totalizer encoding (GTE) [20] for pseudo-Boolean constraints.

Relatively to the MSE17 version, we did the following improvements: (i) we incorporated solution-based phase saving [21], [22], and (ii) for weighted problems, we dynamically choose between the Adder encoding and the GTE encoding. We choose the former when the number of auxiliary clauses created by the GTE encoding exceeds 3,000,000.

IV. Availability

The latest release of Open-WBO is available under a MIT license in GitHub at *https://github.com/sat-group/open-wbo*. To contact the authors please send an email to: `open-wbo@sat.inesc-id.pt`.

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