PB/CT 0.1

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PB/CT is a Pseudo-Boolean and Weighted Boolean solver based on the Satisfiability Modulo Theories solver OpenSMT [2]. Satisfiability Modulo Theories (SMT) is the problem of checking the satisfiability of a first-order logic formula with respect to a background theory $\mathcal{T}$ [1].

OpenSMT implements the so-called lazy or DPLL($\mathcal{T}$) approach, which is based on a tight interaction between a SAT-Solver and a $\mathcal{T}$-solver. The former handles the Boolean component of the problem, whereas the latter checks the satisfiability of conjunctions of predicates in $\mathcal{T}$.

In order to deal with Pseudo-Boolean problems OpenSMT has been extended with the theory of costs [3].

1 Approach

PB/CT works by firstly recognizing Pseudo-Boolean constraints which clearly encode single clauses and translate them into clauses. The remaining constraints are translated in a straightforward way into the theory of costs. Very briefly, the theory consists of two predicates $\mathsf{incur}(v, c, d)$ and $v < b$ where v is a cost variable, and c, d, b are natural numbers. Intuitively, $\mathsf{incur}(v, c, d)$ incurs the cost c on the variable v, and $v < b$ gives an upper bound b on v. A linear Pseudo-Boolean function $\sum_i c_i x_i$ can be encoded into the theory of costs as

$$\bigwedge_i x_i \Leftrightarrow \mathsf{incur}(v, c_i, i)$$

Non-linear functions are linearized by introducing fresh predicates. The third argument to the incur predicate is used to permit incurring the same cost several times on the same cost variable. A Pseudo-Boolean constraint $\sum_i c_i x_i \geq c$ can then be encoded into the theory of costs as

$$\left(\bigwedge_i x_i \Leftrightarrow \mathsf{incur}(v, c_i, i)\right) \wedge \neg(v < c)$$

Soft constraints in weighted boolean optimization are modelled by an additional cost variable w used to encode constraint weights

$$\left(\bigwedge_i x_i \Leftrightarrow \mathsf{incur}(v, c_i, i)\right) \wedge (\neg(v < c) \vee \mathsf{incur}(w, k_j, j))$$

For optimization problems, OpenSMT is called repeatedly assuming bounds on the objective function until the optimum has been found, taking care to reuse learnt information from earlier calls.

2 Availability

Both OpenSMT and PB/CT are open-source solvers available under the Gnu Public License. The source code of both are available from the locations below

OpenSMT	`http://code.google.com/p/opensmt/`
PB/CT	`http://www.residual.se/pbct`

References

1. C. Barrett, R. Sebastiani, S. Seshia, and C. Tinelli. *Handbook on Satisfiability*, volume 185, chapter Satisfiability Modulo Theories. IO Press, 2009.
2. R. Bruttomesso, E. Pek, N. Sharygina, and A. Tsitovich. The OpenSMT Solver. In *TACAS*, volume 6015 of *Lecture Notes in Computer Science*, pages 150–153. Springer Verlag, 2010.
3. A. Cimatti, A. Franzén, A. Griggio, R. Sebastiani, and C. Stenico. Satisfiability Modulo the Theory of Costs: Foundations and Applications. In *TACAS*, volume 6015 of *Lecture Notes in Computer Science*, pages 99–113. Springer-Verlag, 2010.