IPBHS in PB'24 Competition

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I. DESCRIPTION

IPBHS is a solver for pseudo-Boolean optimization (PBO) problems implementing implicit hitting set (IHS) algorithm for PBO [8], [9], [3], [4], [7]. To solve the hitting set problems IPBHS supports different IP-solvers. As a core-extraction oracle, IPBHS uses RoundingSat [5].

To extract more cores in each iteration, IPBHS uses assumption shuffling as described in [9] (assumptions are shuffled 10 times) as well as weight-aware core (WCE) extraction [1]. When the known lower bound for the optimal cost does not improve for 5 iterations, IPBHS tries to improve the upper bound by doing solution-improving search for a limited time.

In PB'24 competition, variants IPBHS-SCIP and IPBHS-GUROBI differ in which IP-solver they use to solve the hitting-set problem: IPBHS-SCIP uses SCIP [2], IPBHS-GUROBI uses Gurobi 10.0.1 [6].

REFERENCES

[1] J. Berg and M. Järvisalo, "Weight-aware core extraction in SAT-based MaxSAT solving," in *Proc. CP*, ser. Lecture Notes in Computer Science, vol. 10416. Springer, 2017, pp. 652–670.

[2] K. Bestuzheva, M. Besançon, W.-K. Chen, A. Chmiela, T. Donkiewicz, J. van Doornmalen, L. Eifler, O. Gaul, G. Gamrath, A. Gleixner *et al.*, "The scip optimization suite 8.0," *arXiv preprint arXiv:2112.08872*, 2021.

[3] J. Davies and F. Bacchus, "Solving MAXSAT by solving a sequence of simpler SAT instances," in *Proc. CP*, ser. Lecture Notes in Computer Science, vol. 6876. Springer, 2011, pp. 225–239.

[4] ——, "Postponing optimization to speed up MAXSAT solving," in *Principles and Practice of Constraint Programming - 19th International Conference, CP 2013*, ser. Lecture Notes in Computer Science, vol. 8124. Springer, 2013, pp. 247–262.

[5] J. Elffers and J. Nordström, "Divide and conquer: Towards faster pseudo-boolean solving," in *Proceedings of the Twenty-Seventh International Joint Conference on Artificial Intelligence, IJCAI 2018, July 13-19, 2018, Stockholm, Sweden*, J. Lang, Ed. ijcai.org, 2018, pp. 1291–1299. [Online]. Available: https://doi.org/10.24963/ijcai.2018/180

[6] Gurobi Optimization, LLC, "Gurobi Optimizer Reference Manual," 2024. [Online]. Available: https://www.gurobi.com

[7] P. Saikko, J. Berg, and M. Järvisalo, "LMHS: A SAT-IP hybrid MaxSAT solver," in *Theory and Applications of Satisfiability Testing, SAT 2016*, ser. Lecture Notes in Computer Science, vol. 9710. Springer, 2016, pp. 539–546.

[8] P. Smirnov, J. Berg, and M. Järvisalo, "Pseudo-boolean optimization by implicit hitting sets," in *27th International Conference on Principles and Practice of Constraint Programming, CP 2021, Montpellier, France (Virtual Conference), October 25-29, 2021*, ser. LIPIcs, L. D. Michel, Ed., vol. 210. Schloss Dagstuhl - Leibniz-Zentrum für Informatik, 2021, pp. 51:1–51:20. [Online]. Available: https://doi.org/10.4230/LIPIcs.CP.2021.51

[9] ——, "Improvements to the implicit hitting set approach to pseudo-boolean optimization," in *25th International Conference on Theory and Applications of Satisfiability Testing, SAT 2022, August 2-5, 2022, Haifa, Israel*, ser. LIPIcs, K. S. Meel and O. Strichman, Eds., vol. 236. Schloss Dagstuhl - Leibniz-Zentrum für Informatik, 2022, pp. 13:1–13:18. [Online]. Available: https://doi.org/10.4230/LIPIcs.SAT.2022.13