ParLS-PBO: a parallel local search solver in the PBO Competition 2024

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Abstract—This document describes a parallel Pseudo-Boolean Optimization (PBO) solver *ParLS-PBO*, submitted to the DEC-LIN and OPT-LIN tracks of the PBO competition 2024[1].

On top of *DLS-PBO*[2], we developed *ParLS-PBO*, a parallel PBO solver. *ParLS-PBO* contains a master and multiple workers. The master is responsible for assigning jobs and monitoring the behaviors of workers. When all workers return results, the master terminates all workers and selects the best result. Workers are responsible for task solving, and each worker corresponds to the sequential PBO solver *DLS-PBO*, supplemented with information sharing to accelerate the solution process. Specifically, *ParLS-PBO* has the following three key ideas.

- Literal assume: To make the search space of each worker not similar, we introduce the literal assume technique. Suppose there are T workers, and the master thread selects $\lceil \frac{T}{2} \rceil$ random variables, resulting in T literals, which will be assigned to each worker as assumptions. Then each worker receives an assumed literal and applies the unit propagation technique to simplify the formula.
- Solution sharing: *ParLS-PBO* maintains a solution pool to store high-quality solutions. Whenever a worker gets stuck in the search process, it selects a solution from the pool to replace its current solution and restarts the search. The maintenance of the solution pool considers both the quality and diversity of solutions, ensuring that the search spaces of the workers do not converge.
- Polarity density weight: Besides the solution pool, we propose a deeper guiding method, which utilizes a piece of valuable hidden information in the solution pool — the occurrence of polarities (0 or 1) of variables. The polarity of variables in each good solution is statistically analyzed and used as a parameter to influence the scoring function across all workers, further guiding the search process.

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[1]Relevant work has been accepted by the 30th International Conference on Principles and Practice of Constraint Programming (CP 2024).

[2]Details are introduced in our other document, DLS-PBO: the sequential local search solver in the PBO Competition 2024.