DeciLS-PBO: an Effective Local Search Method for Pseudo-Boolean Optimization

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Problems & Ideas

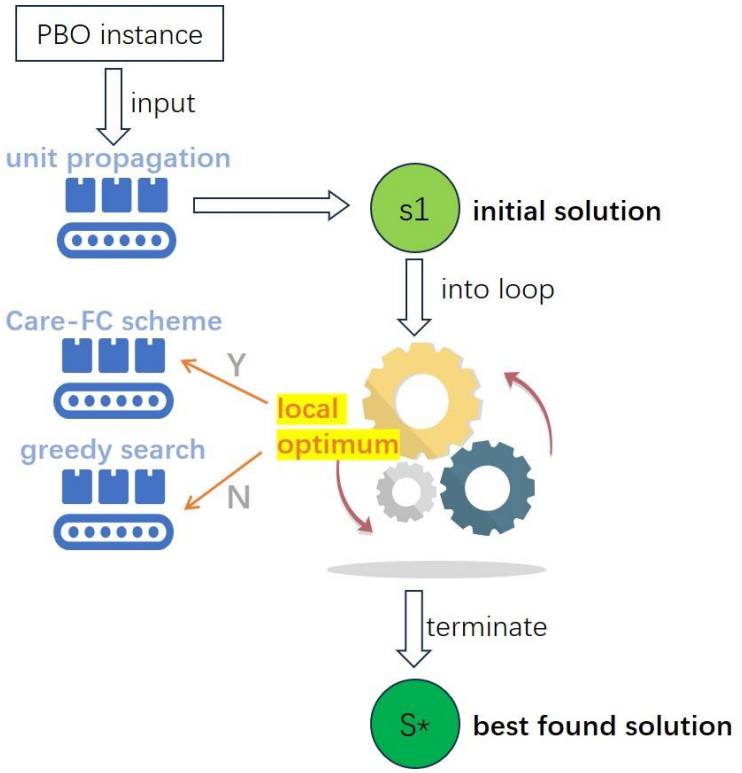
- Pseudo-Boolean Optimization Problem:
  - A pseudo-Boolean (PB) constraint is an inequality of the form $\sum a_i \cdot l_i \geq B$, where a_i and B are positive integers , and each l_i is a literal over Boolean variable x_i.
  - The Pseudo-Boolean Optimization (PBO) problem consists of a set of PB constraints and an objective function that minimizes $\sum b_i \cdot l_i$ where each b_i is a positive integer.
  - The purpose of the PBO problem is to find a solution that minimizes the value of the objective function under the premise that all PB constraints must be satisfied.

- Ideas:

An improved local search algorithm for solving the PBO problem based on two new components: a unit propagation based initialization and a new heuristic called Care-FC scheme.

The unit propagation process works at the initial stage to generate a better initial solution.

The Care-FC scheme works when the algorithm falls into a local optimum. It provides two ways to select a constraint, helps the algorithm choose the next variable to flip.



Main Contributions

- Contributions:
  - The proposed DeciLS-PBO algorithm defines two types of unit clauses for PBO problem;
  - DeciLS-PBO combines unit propagation based decimation algorithm for a better initial solution generation;
  - A Care-FC scheme provides a new way to select a constraint when the algorithm falls into a local optimum.
- Experiments:
  - Compared with the state-of-the-art complete and incomplete PBO solvers, the proposed DeciLS-PBO algorithm wins on most instances.

Instances	#inst	DeciLS-PBO	LS-PBO	PBO-IHS
MWCB	24	**22**	2	0
WSNO	18	13	**18**	1
SAP	21	**17**	5	0
PB16	1600	1130	1045	**1171**
total	1663	**1182**	1070	1172

Instances	#inst	DeciLS-PBO	LS-PBO	PBO-IHS
MWCB	24	**22**	2	0
WSNO	18	**18**	**18**	2
SAP	21	**16**	6	0
PB16	1600	**1215**	1142	1185
total	1663	**1271**	1168	1187

Left: #win number of DeciLS-PBO and its competitors under 300s time limit.
Right: #win number of DeciLS-PBO and its competitors under 3600s time limit.