Pseudo Code for Repair Algorithm

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1 Input

- A problem P^0 with n binary variables x, objective function cx (min), constraint set C^0 with an optimal solution x^0.
- A problem P^1 with n binary variables x, objective function cx (min), constraint set C^1, such that $C^0 \subsetneq C^1$.

2 Output

- An optimal solution x^1 to P^1.

3 General Idea

We propose to solve P^1 by reusing the optimal solution x^0 to P^0. In order to achieve this, we define a new problem Q with constraint set C^1 and objective function

$$\min cx + \alpha|x - x^0|,$$

where $|x - x^0| = \sum_{i=0}^{n-1}|x_i - x_i^0|$, and α is a *penalty* term for deviating from the input solution x^0. This would tentatively help the search for a good solution to P^1. However, unless x^0 is feasible for P^1, an optimal solution to Q will in general not be optimal for P^1.

To remedy this problem, we will instead solve a sequence of problems $Q^0, Q^1, \ldots$, where the penalty factor α will gradually decrease until it reaches 0, say at iteration k, in which case $Q^k = P^1$. This sequence of problems can be efficiently solved using a technique called *reoptimisation*, which is implemented in the MIP solver SCIP.

4 Pseudo Code

5 MIP

5.1 Mixed Integer Programming

Definition 5.1. (Mixed Integer Programming)
Let $m, n \in \mathbb{N}$, The given matrix $A \in \mathbb{R}^{m \times n}$, vectors $b \in \mathbb{R}^m$, and the vector $c \in \mathbb{R}^n$, and a set $\mathcal{I} \subseteq N = \{1, \ldots, n\}$. the problem

$$
\begin{aligned}
\text{(MIP)} \quad & c^* = \min c^T x \\
& s.t. \quad Ax \geq b \\
& \qquad\quad x_i \in \mathbb{Z}_{\geq 0} \quad \forall_i \in \mathcal{I} \\
& \qquad\quad x_j \in \mathbb{R}_{\geq 0} \quad \forall_i \in \mathcal{N} \setminus \mathcal{I}
\end{aligned}
$$

is called $mixedintegerprogram$ with the objective function $c^T x$ and constraints $A_i x \geq b_i$ for all $i = 1, \ldots, m$. A vector $x \in X_{MIP} = \{x \in \mathbb{R}_{\geq} 0^n \mid A_x \geq b,\, x_i \in \mathbb{Z}_{\geq 0} \, \forall i \in \mathcal{I}\}$ is called $feasiablesolution$ and X_{MIP} the set of feasible solutions. A feasible x^* is called optimal, if x^* satisfies $c^* = c^T x^*$