

Pseudo Code for Repair Algorithm

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1 Introduction

In this section, we define some important definitions and algorithms....

Definition 1.1. (Mixed Integer Programming)

In this report we consider a generic mixed-integer programming problem (MIP) in the following form

$$\begin{aligned} \text{(MIP)} \quad & \min \quad c^T x \\ \text{s.t.} \quad & Ax \geq b \\ & x_j \in \mathbb{Z} \quad \forall j \in \mathcal{I} \\ & x_j \in \mathbb{R} \quad \forall j \in \mathcal{N} \setminus \mathcal{I} \end{aligned}$$

where the vector $b \in \mathbb{R}^m$ and the vector $c \in \mathbb{R}^n$ are input vectors. A is a input matrix of size $m \times n$, the variable input set $\mathcal{I} \subseteq \mathcal{N} = \{1, 2, \dots, n\}$. We denote \mathcal{P} for this problem, which called a mixed-integer programming problem (MIP) with minimize objective function $c^T x$ subject to the constraints $Ax \geq b$. Besides, some variables are restricted to integer values while the else of are restricted to real value. S is a set of feasible solution if S satisfy all the constraints in the problem. A vector s^* with $s^* \in S$ is called *optimal solution* when $c^T x_{s^*} \leq c^T x_s$ for $\forall s \in S$. When all of the variables are restricted to integer, the problem is called *pureintegerlinearprogram*(IP) for $\mathcal{I} = \mathcal{N}$. If there is no integrality constraint, the program is called *linearprogram*

$$\begin{aligned} \text{(MIP)} \quad & \min \quad c^T x \\ \text{s.t.} \quad & Ax \geq b \\ & x_j \in \mathbb{R} \quad \forall j \in \mathcal{N} \end{aligned}$$

Definition 1.2. (LP-relaxation)

Lp *relaxation* is obtained by removing all integrity constraints $\mathcal{I} \leftarrow \emptyset$. LP-*relaxation* is the foundation of LP-based branch-and-bound technology. As the searching space is increase by removing integrity restrictions, the optimal solution in MIP problem could not better than LP-*relaxation*, which is $s_{MIP}^* \geq s_{LP}^*$. This means the optimal solution found in LP problem could provide a lower or prime bound for MIP problem.

2 Input

- A MIP problem \mathcal{P}^0 with n variables x , constraint set C^0 with an optimal solution s^0 , where s^0 is a n -vector.
- A MIP problem \mathcal{P}^1 with n variables x , constraint set C^1 , such that $C^0 \subsetneq C^1$.

3 Output

- An optimal solution s^1 to \mathcal{P}^1 , where s^1 is a n -vector too.

4 Pseudo Code

Algorithm 1: Solving Problem with Reoptimization

Input: \mathcal{P}^1 where $C^0 \subsetneq C^1$ and s^0, k

Output: optimal solution s^* to \mathcal{P}^1

```
1 begin
2   if  $s^0$  is feasible to  $\mathcal{P}^1$  then
3     return  $s^0$ 
4   else
5      $\alpha \leftarrow k \times c^T s^0$ 
6     for  $j$  in  $\mathcal{I}$  do
7        $\mathcal{P}^2 \leftarrow$  create new variables  $y_j$  with objective value  $\alpha$  and add it to  $\mathcal{P}^2$ :  

7                                     // add new variables
8        $\mathcal{P}^2 \leftarrow$  add new constraints to  $\mathcal{P}^2 : y_j \geq x_j - s_j^0$       // add new constraints
9        $\mathcal{P}^2 \leftarrow$  add new constraints to  $\mathcal{P}^2 : y_j \geq s_j^0 - x_j$ 
10    end
11     $r \leftarrow 1$ 
12    while  $\alpha > 0$  do
13       $\alpha \leftarrow \alpha - \frac{\alpha}{k}$ 
14      update the variable  $y_j$  coefficient
15       $s^r \leftarrow$  solve  $\mathcal{P}_r^2$  ( $r$ -th iteration) to optimal or stop criterion with reoptimization
16       $r \leftarrow r + 1$ 
17    end
18     $s^* \leftarrow s^r$ 
19    return  $s^*$ 
20  end
21 end
```
