k-Traveling Repairman Problem and Parallel Machines Scheduling

Research practice 2

Functional analysis and applications research group

Universidad EAFIT

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What is the problem?

- Given a set of activities and a set of resources, each activity must be made exactly once
- The resources cannot process activities simultaneously
- The weighted sum of start times is optimized
- The activities 0 and $n+1$ are dummy activities and they indicate the start and the end of the work

Objectives

- Design of metaheuristic algorithms for solving both of the proposed combinatorial optimization.
- Evaluate and compare the performance of the optimization models being applied to k-TRP and scheduling of machines.
- Evaluate the impact of the stochasticity in the problem solution.
- Design alternative methods or models that reduce the impact of the stochasticity in the solution.

$$Min\ Z = \sum_{i=1}^{n} t_i \cdot w_i \quad (1)$$

$$\sum_{i=0}^{n+1} x_{ij} = 1 \qquad \forall\ j \in J \backslash \{0, n+1\} \quad (2)$$

$$\sum_{j=0}^{n+1} x_{ij} = 1 \qquad \forall\ i \in J \backslash \{0, n+1\} \quad (3)$$

$$\sum_{j=1}^{n} x_{0j} = m \quad (4)$$

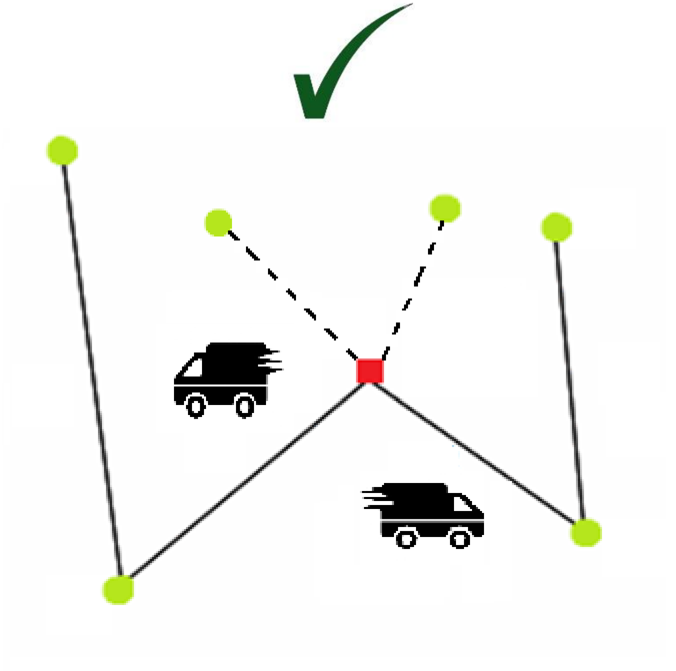
$$t_j \geq t_i + s_{ij} + p_j - T \cdot (1 - x_{ij}) \qquad \forall\ i, j \in J \quad (5)$$

$$x_{ij} \in \{0,1\} \qquad \forall\ i, j \in J \quad (6)$$

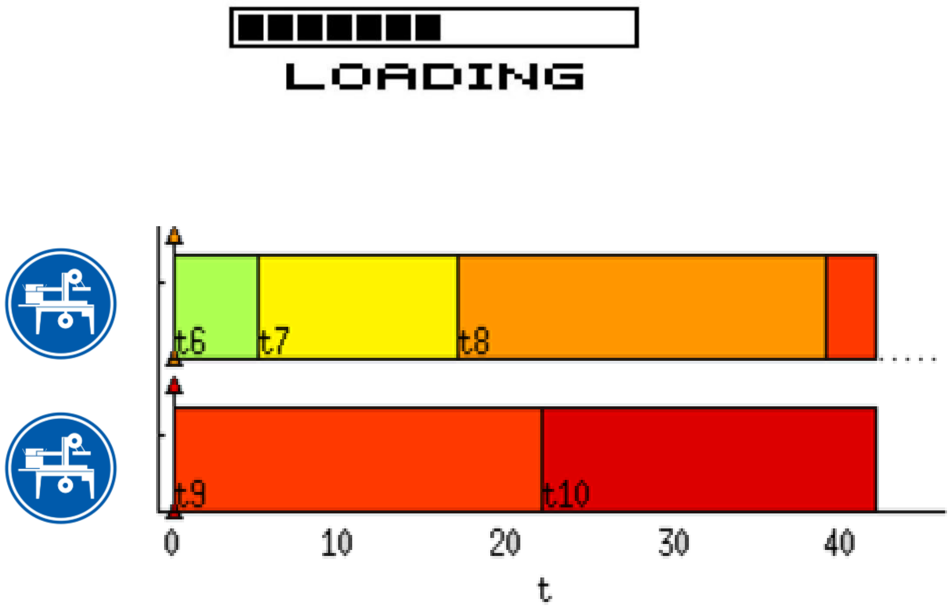
$$t_j \geq 0 \qquad \forall\ j \in J \quad (7)$$

- $\boldsymbol{x_{ij}}$: binary variable that indicates if the activity i is executed next the activity j
- $\boldsymbol{t_j}$: decision variable that represents the completion time of the activity j
- $\boldsymbol{s_{ij}}$: transition time between the activity i and activity j
- $\boldsymbol{p_j}$: time to process the activity j
- $\boldsymbol{w_i}$: represent the importance of the work i

Initial solution

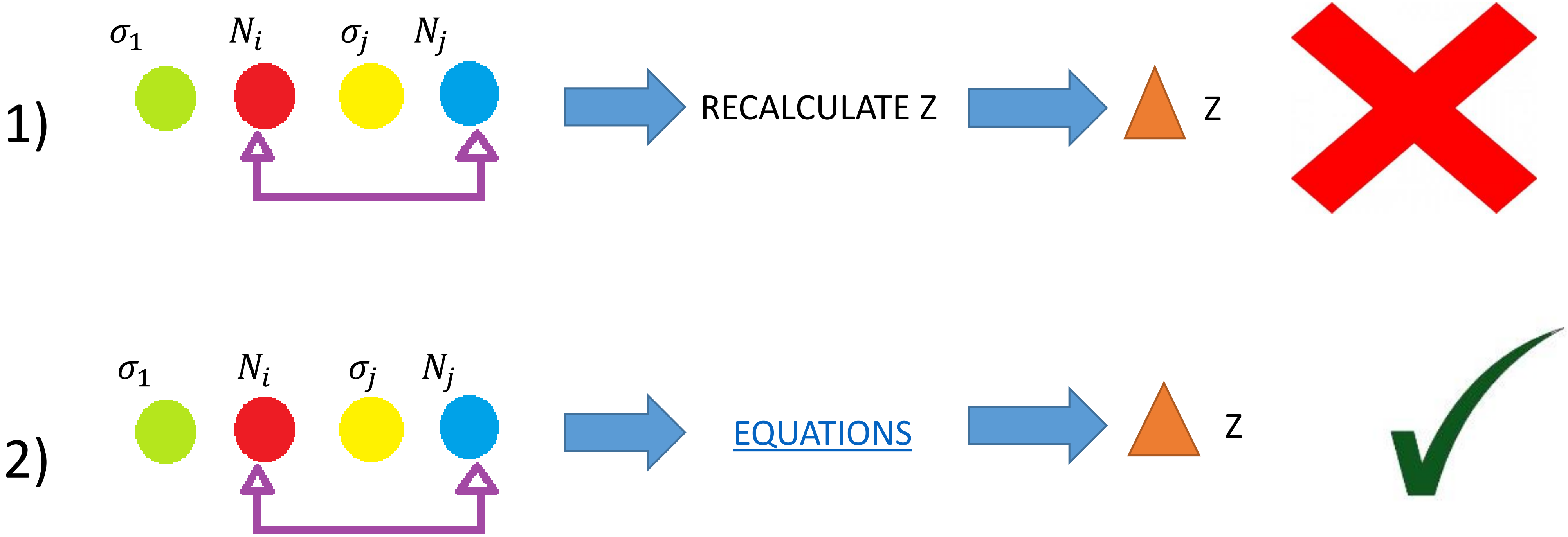


Traveling repairman



Machines scheduling

Efficient variable neighborhood



Useful equations

Being σ a sequence, Define:

$$W_\sigma = \sum_{i=1}^{\sigma} w_{\sigma(i)} \qquad (1)$$

$$D_\sigma = \sum_{i=1}^{\sigma-1} d_{\sigma(i),\sigma(i+1)} \qquad (2)$$

$$C_\sigma = \sum_{i=1}^{\sigma-1} \left(d_{\sigma(i),\sigma(i+1)} \cdot \sum_{j=i+1}^{\sigma} w_{\sigma(j)} \right) \qquad (3)$$

Given two sequences: $A = \{1,2,3\}$ && $B = \{4,5\}$

$A \oplus B$ Then from (1),(2) and (3)

$$W_{A \oplus B} = W_A + W_B \quad (4)$$

$$D_{A \oplus B} = D_A + d_{34} + D_B \quad (5)$$

$$C_{A \oplus B} = C_A + W_B \, (D_A + d_{34}) + C_B \quad (6)$$

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ELS-Pseudocode

```
Read (coordinates, numberOfVehicles, demands)
while stopCondition1 do
    s = s_0
    s = vnd(s)
    while stopCondition2 do
        ss = s
        for n − times do
            maybeSol = pert(ss)
            ss = vnd(maybeSol)
        end for
        if f(ss) < f(s) then
            s = ss
        end if
    end while
end while
```

Why to do this?

- Industrial applications, such as machines scheduling and goods distribution.

- The complexity (np-hard) of the problems provides an appropriate field of research.

- The problems are part of the current state of the art in areas like the operations research, applied mathematics and optimization.

QUESTIONS?