Implementation and analysis of models and methods to solve combinatorial optimization problems under uncertainty

Reserarch practice 2 (Project proposal)

Functional analysis and applications research group

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What is the problem?

- Given a set of $n + 2$ activities and a set of m resources. Each activity must be assigned to a resource and all the activities are made only once
- The resources cannot process activities simultaneously
- An objective function is optimized
- The activities 0 and $n + 1$ are dummy activities and they indicate the start and the end of the work

The objective is to find the order (or starting times) to process the activities that maximizes or minimizes an objective function.

The more common objective functions are:

- The minimization of completion times of all activities (or the completion time of the last executed activity)
- The minimization of the sum of starting times (or ending times) of all the activities
- The minimization of the sum of all the processing times including fixed times

Mathematical model

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

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

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

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

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

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

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

- $\boldsymbol{x_{ij}}$: 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

Objectives

- Design of metaheuristic algorithms for solving the proposed combinatorial optimization problems or any of its variants.
- Evaluate and compare the performance of the optimization models being applied to the vehicle routing problem and scheduling of machines.
- Design a simulation mechanism that creates multiples scenarios to 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.
- Write an article with the description of the algorithms, experiments and results of the research.

Why to do this?

- This type of problems have many industrial applications, such as machines scheduling and goods distribution.
- The complexity of the heuristics and metaheuristics algorithms is considerable and provides an appropriate field of research.
- The problems and applications proposed as well as the methods that are considered in this research, are part of the current state of the art in areas like the operations research, applied mathematics and optimization.

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