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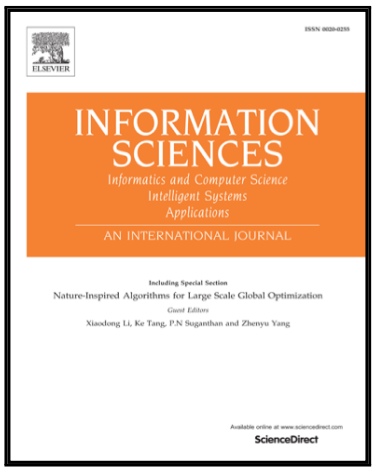

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Consolidated Optimization Algorithm for Resource-constrained Project Scheduling Problems

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Abstract

Resource-constrained project scheduling problems (RCPSPs) represent an important class of practical problems. Over the years, many optimization algorithms for solving them have been proposed, with their performances of such algorithms evaluated using well-established test instances with various levels of complexity. While it is desirable to obtain a high-quality solution and fast rate of convergence from an optimization algorithm, no single one performs well across the entire space of instances. Furthermore, even for a given algorithm, the optimal choice of its operators and control parameters may vary from one problem to another. To deal with this issue, we present a generic framework for solving RCPSPs in which various meta-heuristics, each with multiple search operators, are self-adaptively used during the search process and more emphasis is placed on the better-performing algorithms, and their underlying search operators. To further improve the rate of convergence and introduce good-quality solutions into the population earlier, a local search approach is introduced. The experimental results clearly indicate the capability of the proposed algorithm to attain high-quality results using a small population. Compared with several state-of-the-art algorithms, the proposed one delivers the best solutions for problems with 30 and 60 activities, and is very competitive for those involving 120 activities.

Keywords: Resource-constrained project scheduling problems, evolutionary algorithms, multi-algorithm, multi-operator

1. Introduction

Resource constrained project scheduling problems (RCPSPs) represent one of the most important and challenging scheduling problems and are known to be NP-hard [10]. Such problems are at the heart of many applications, e.g., job-shop scheduling problems [17], and can be found in construction management, the production of cars, rolling ingots and assembly shop scheduling [9, 8].

The aim of an RCPSP is to find the optimal schedule of a set of activities that minimizes the total duration of the project (makespan) while satisfying some constraints. Generally, a single project consists of $D+2$ activities, i.e., $\{1, 2, .., j, ..., D+2\}$, where the first and last are dummies to be scheduled, each of which has a duration (d_j). There are different types of resources, i.e., $R = \{R_1, ..., R_k, ..., R_K\}$, with each activity requiring r_{kj} units of the k^{th} type of resource. Note that a dummy activity is one with $d_j = 0$ and $r_{kj} = 0, \forall\, k = \{1, 2, ...K\}$. In this paper, we assume that an activity in progress cannot be interrupted, and the following two kinds of constraints need to be satisfied.

1. Precedence constraint: the j^{th} activity cannot be started before the completion of all its predecessors, that is, its starting time (ST_j) is always greater than or equal to the maximum finish time (FT) of its predecessors.
2. Resource constraint: the r_k required by the j^{th} activity should be less than or equal to the available R_k at each time step.

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