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A Memetic Algorithm for the Resource Constrained Project Scheduling Problem

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Abstract

The Resource Constrained Project Scheduling Problem (RCPSP) consists in determining the start times for a set of activities whose execution requires certain resources, but with limited quantities of resources available, so as to minimize the overall execution time (known as the makespan). This problem is quite well known, and a number of metaheuristics have been applied to it, including Genetic Algorithms, Tabu searches, Simulated Annealing, Scatter searches and other complex hybrid techniques. Some of these methods show good performances when complex techniques are integrated. In this paper we present a hybrid Genetic Algorithm (GA) which integrates local searches for mutation. We call this kind of hybrid GA a Memetic Algorithm (MA). Computational experiments were run on a standard set of 1560 instances. The results show that our Memetic Algorithm is competitive with the best known algorithms. For all instance sets our algorithm comes a close second behind the best algorithm in each case. Since the highest-ranking algorithm is not the same one each time, but varies according to the particular data set, our algorithm may be considered as having the best overall performance.

Key words: RCPSP, Memetic Algorithm, Destruction/Construction.

1 Introduction

Project scheduling concerns single-item or small batch production where scarce resources have to be allocated over time to dependent activities. In the literature the types of resource most often considered are renewable resources such as the workforce. Renewable resources are allocated to activities when they start, and released when they complete. Note that the allocated resource units are required throughout the entire processing time of the activity. An emblematic example is the Resource Constrained Project Scheduling Problem (RCPSP), denoted as $m, 1|cpm|C_{max}$, using the classification scheme of Herroelen et al. [1]. Over the last few decades RCPSP has attracted increasing attention both a scientific and a practical perspective, as an NP-hard optimization problem. Several surveys are to be found [2–6].

A number of exact and heuristic algorithms have been proposed but since the problem is NP-Hard, the computational times for exact methods can be very high, even for instances of only moderate size. This has been the motivation for research aimed at developing efficient heuristic methods. Alcaraz and Maroto [7] and Hartmann [8] deal with the RCPSP by implementing genetic algorithms, whereas Bouleimen and Lecocq [9] use simulated annealing. Fleszar and Hindi [10] present a heuristic they refer to as a Variable Neighborhood Search. Nonobe and Ibaraki [11] propose a Tabu search procedure that is applied to both

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