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Iterated Greedy with Random Variable Neighborhood Descent for Scheduling Jobs on Parallel Machines with Deterioration Effect

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Abstract

In this paper, we study an unrelated parallel machine scheduling problem in which the jobs cause deterioration of the machines. This deterioration decreases the performance of the machines, and therefore, the processing times of the jobs are increased over time. The problem is to find the processing sequence of jobs on each machine in order to reduce the deterioration of the machines and consequently minimize the makespan. This problem is NP-hard when the number of machines is greater or equal than two, and hence we propose a heuristic based on the Iterated Greedy meta-heuristic coupled with a variant of the Variable Neighborhood Descent method that uses a random ordering of neighborhoods in local search phase. The performance of our heuristic, named IG-RVND, is compared with the state-of-the-art meta-heuristic proposed in the literature for the problem under study. The results show that the our heuristic outperform the existing algorithm by a significant margin.

Keywords: Scheduling, Unrelated Parallel Machines, Deterioration Effect, Iterated Greedy, Variable Neighborhood Descent.

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1 Introduction

In deterministic scheduling problems, the job processing times are generally known in advance and remain constant during the scheduling horizon. However, there are many practical situations in which the processing time of a job may increase over time, such that the later a job starts, the longer it takes to be processed. This phenomenon is known as the job processing time deterioration effect [8].

There are at least two models of scheduling with job deterioration effect in the literature. In the first model, the actual processing time of a job is defined as an increasing function of its start time [4,1]. The second model defines the job processing time as a function of the jobs position in the machine sequence, that is, the actual processing time of a job may vary depending on its scheduled position in a job sequence [8,3].

Ruiz-Torres et al. [7] addressed a different model of the job deterioration problem that considers the case where the deterioration of the processing time for a job depends on the specific jobs that have been previously processed by the machine. The deterioration of a machine produces an increment of job processing times. In [7] is presented a Simulated Annealing (SA) heuristic to minimize the makespan on unrelated parallel machines.

In this paper we address the same problem formulated by Ruiz-Torres et al. [7]. To the best of our knowledge, this problem has only been studied by these authors. To solve the problem, we propose a heuristic based on the Iterated Greedy (IG) meta-heuristic [6] that applies a Random Variable Neighborhood Descent (RVND) [2] as local search. The performance of our heuristic is compared with the SA heuristic proposed by Ruiz-Torres et al. [7].

The remainder of this paper is organized as follows. Section 2 contains problem description. The components of the proposed heuristic are presented in Section 3. The computational experiments and analyses of the obtained results are presented in Section 4. Finally, Section 5 presents the conclusions obtained.

2 Problem description

There is a set of n independent jobs, $N = \{1, \ldots, n\}$, to be processed on m unrelated parallel machines, $M = \{1, \ldots, m\}$. All jobs are available for processing at time zero and job preemption is not allowed. Each machine can process at most one job at a time and can not stand idle until the last job assigned to it has been finished. The normal processing time of job j on

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