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A DECOMPOSITION-BASED OPTIMIZATION ALGORITHM FOR SCHEDULING LARGE-SCALE JOB SHOPS

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Abstract. *A decomposition-based optimization algorithm is presented for large-scale job shop scheduling problems in which the total weighted tardiness should be minimized. The algorithm adopts an iterative optimization framework. In each iteration, a new subproblem is first defined by a simulated annealing approach and then solved using a particle swarm optimization algorithm. In order to promote the optimization efficiency, the jobs' bottleneck characteristic values are calculated and utilized as an immune mechanism to guide the subproblem-solving process. Numerical computations and comparisons are conducted for both randomly generated test problems and the real-life production environment of a speed-reducer factory in China. Experiment results reveal the unique advantages of the proposed algorithm over the existing methods.*

Keywords: Job shop scheduling problem, Decomposition, Simulated annealing, Particle swarm optimization, Bottleneck

1. **Introduction.** The job shop scheduling problem (JSSP) has been known as a notoriously stubborn combinatorial optimization problem since the 1950s and it has been shown to be $\mathcal{NP}$-hard in the strong sense [1]. Therefore, it was considerably difficult to obtain the optimal solution even for small-scale JSSP instances. Unforgettably, the famous test problem "FT10" which consists of only 10 machines and 10 jobs once took researchers nearly two decades to solve to optimality [2]. In recent years, local search strategies, such as genetic algorithm (GA) [3, 4] and particle swarm optimization (PSO) [5, 6], quickly became the center of heuristic optimization methods. These meta-heuristic approaches have undoubtedly played a significant role in solving small-scale scheduling problems [7, 8].

However, in practical manufacturing environment, the scale of job shops is generally much larger; for example, in some mechanical workshops, the number of operations to be scheduled per day may be up to 10 000. As the problem size grows, the solution space will expand exponentially, and consequently, the performance of traditional mathematical or heuristic algorithms can hardly be satisfactory. To address the difficulty caused by the large problem scale, several decomposition-based methods have already been proposed [9, 10, 11, 12, 13, 14, 15, 16, 17], which decompose the original large-scale problem into a series of smaller problems (i.e., subproblems) by certain means and finally construct the complete schedule after solving these subproblems respectively. However, there are some obvious drawbacks with these existing approaches:

(1) In order to produce subproblems with feasible solutions, some existing algorithms (for example, [12]) impose many extra constraints to each subproblem. This always results in considerable deterioration of the final solution quality.