Multi-objective Flexible Job Shop Scheduling Problem: Simulation Approach

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1 Introduction

In traditional Job Shop Scheduling Problem (JSP), there are *n* jobs and *m* machines in manufacturing system, where each job consists of *j* operations that need to be executed on machines by a given order. Flexible Job Shop Scheduling Problem (FJSP) is an extension of classic JSP. It extends the assumption that only one machine is able to run a particular operation. Since JSP can be considered as a special case of FJSP and JSP is well-known NP-hard, FJSP is also regarded as an NP-hard problem.

Considering its computational complexity, various metaheuristic have been extensively applied to FJSP. Zendieh et al.[9] proposed a Genetic Algorithm by using several different rules for generating the initial population and several strategies for producing new population for next generation. Gao et al.[6] introduced a Pareto-based grouping discrete harmony search algorithm (PGDHS) to solve FJSP. Chamber et al. [1]extended their Tabu Search strategy previously described for job shops and applied it to FJSP. Besides metaheuristic algorithm, researchers also employ traditional polynomial algorithms and hybrid algorithms[5] in FJSP.

The objective of Flexible Job Shop Scheduling Problem is to determine a feasible schedule *S* by minimizing a given objective function [4]. In early work, the wide-used objective is from a single dimension, considering only one objective once. Recently, researchers [5][10] have addressed their study on multiple objectives.

In this paper, a novel dynamic scheduling algorithm based on simulation environment is proposed to schedule transportation tasks in FJSP with five objectives, such as the minimization of makespan and transportation distance. The dynamic algorithm, we proposed in this paper, is developed from a previous study in the LINEACT laboratory[2][3][7][8]. We improve the decision process in order to avoid being trapped in local solutions, and the novel dynamic algorithm makes it possible to get schedule results from the simulator directly.

2 Simulation Model and Findings

For simulating different scenarios of a flexible manufacturing systems in Netlogo, we developed a multi-agent model, where the proposed dynamic algorithm embedded. To illustrate the effectiveness of the model, we benchmark it with traditional FIFO (First In First Out) algorithm and metaheuristic GA (Genetic Algorithm) model. In current comparisons, we only consider two criteria in dynamic algorithm, makespan and distance. Still, the model shows its competitiveness. From the tests we have done, it is easy to find that our proposed method always offers non-dominated solutions compared to GA method. Moreover, our dynamic algorithm only consumes a much shorter computational time to find an equally efficient solution. We believe that when we compare these methods with all five objectives, the results would be even much better.

3 Conclusions and perspectives

Compared to other algorithms, simulation algorithm is able to deal with arbitrary scenarios and monitor all elements in the system simultaneously. In this paper, we introduce a novel simulation approach to solve flexible job shop scheduling problem. The comparative results show that the performance of our algorithm is non-dominated to that of others, sometimes even could offer a better solution. Moreover, the computational time could be saved a lot when having more objectives or more complex assumptions.

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