Genetic Algorithm for a Large-Scale Scheduling Problem in an Electric Wire Production Process

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1 INTRODUCTION

This paper deals with a scheduling problem in a real electric wire production process. The process is of a flow-shop with two subprocesses. In each subprocess plural machines are arranged in parallel. The objective is to minimize the sum of the tardiness of each product. In addition, the problem has complicated constraints.

In our earlier paper (Iima et al., 1999), a GA (called GA0) was applied to the problem for the case where the number of products is not large. In this paper a larger-scale case is treated for the same problem. Three methods (called GA1, GA2 and GA3) are proposed by introducing a decomposition procedure.

2 DECOMPOSITION PROCEDURES

The genotype is defined as a sequence of products. The gene at the i-th locus represents the product to be processed in the i-th order.

2.1 GA1

Step 1 Decompose all products into B groups H^b ($b = 1, 2, \cdots, B$) in the order of the due date.
Step 2 Set $b \leftarrow 1$.
Step 3 Determine a scheduling plan of products in group H^b by GA0. In this procedure each individual consists of only genes corresponding to the products in H^b.
Step 4 If $b < B$, set $b \leftarrow b + 1$ and return to Step 3.
Step 5 The total scheduling plan is obtained by combining the scheduling plans in the order of b.

2.2 GA2

GA2 is the same as GA1 except the objective function. The products should be processed as soon as possible if the products of the remaining groups are taken into consideration. Thus the makespan is added as a penalty function. It is noted that the objective for this problem is only the sum of tardiness.

Table 1: Computational Result

Method	GA0	GA1	GA2	GA3
Sum of tardiness	644486	83872	72806	58329

2.3 GA3

Step 1 Decompose all products into B groups H^b ($b = 1, 2, \cdots, B$) in the order of the due date.
Step 2 Set generation $g \leftarrow 1$. Generate individuals at the initial generation. Each individual consists of B chromosomes that are generated by sequencing at random the products in the respective groups H^b ($b = 1, 2, \cdots, B$).
Step 3 Carry out the reproduction operation in the same way as GA0.
Step 4 Carry out the crossover operation and the mutation operation in the same way as GA0. Both operations are carried out independently for each chromosome.
Step 5 If $g = GE$, terminate the algorithm. If $g < GE$, set $g \leftarrow g + 1$ and return to Step 3.

3 NUMERICAL RESULT

The proposed methods are applied to real data where the number of products is set to be 560. Table 1 shows the objective values of the suboptimal solutions obtained by various GAs. The value of B is set to be 8 in each method. The final generation is set to be 10000 for GA3, and 1000 for the other GAs. It is observed from the table that GA3 is the best method. The computation time in GA3, however, is about ten times as large as that in the other methods. If the objective value is compared among the solutions at 1000-th generation, GA2 is the best method.

Reference

H. Iima, O. Mitsui, N. Sannomiya and R. Sakakibara (1999). Genetic Algorithm for a Scheduling Problem in an Electric Wire Production System with Three Subprocesses. *Preprints of 14th IFAC World Congress* (to appear).