Optimal Design of Facility Layout Considering Unequal-area and Fixed-shapes by Hybrid GA

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Abstract

In this paper, we present a hybrid genetic algorithm that can provide an improved solution in facility layout problems. The existing algorithms for the problem of assigning positions to unequal-area and fixed-shape departments within a given building area could produce solutions with some weak points, which require extensive manual revision to create practical layouts and produce irregular building shapes and too much unusable spaces. Thus, the hybrid genetic algorithm (Hybrid-GA), which can obtain solutions satisfying the given geometric constraints of unequal-area and fixed-shapes, is proposed and tested for minimizing total material handling cost and maximizing space utilization.

The Hybrid-GA adds the strength of simulated annealing and tabu search algorithms to genetic algorithms to overcome the inherent weakness of an individual algorithm and earlier work in solving layout problems with geometric constraints. The Hybrid-GA is to make up for a weakness in the genetic algorithm by employing the strong points of tabu search (TS) and simulated annealing (SA) that rapidly finds a local optimal solution. That is, the genetic algorithm is powerful to find global optimal solutions, however it takes a lot of computation time. On the other hand, TS and SA are excellent for finding local optimal solution much more quickly. The advantage of Hybrid-GA can be found from two points of view: better solution quality and reasonable computation efforts. The structure of Hybrid-GA can be classified into two types. First type: search initial solutions by employing a genetic algorithm and find a final solution by a heuristic algorithm such as a TS and SA. Second type: reversed procedure of the first type, search a local solution by a heuristic algorithm and employ a genetic algorithm to find an optimal solution over the set of local solutions. The proposed method in this research is the mixed type of existing type 1 and 2 (see Figure 1). That is, one cycle consists of a local search with SA and TS and a global search with GA. This cycle is repeated until stopping condition is reached.

The objective of this paper is to demonstrate the effectiveness of Hybrid-GA in solving

layout problems. In experimental results, for the performance of the model for finding optimal solutions, we found that Hybrid-GA model searched for exactly the same optimal solutions obtained by the enumeration method over 5~10 facilities. Also, for the efficiency of the layout method proposed in this research, percentage reduction in minimum value (costs) of 7.9~11.4% and average costs of 2.7~4.8% were achieved. In the computational efforts, Hybrid-GA model, on the average, takes 2~3 minutes longer than the GA model.

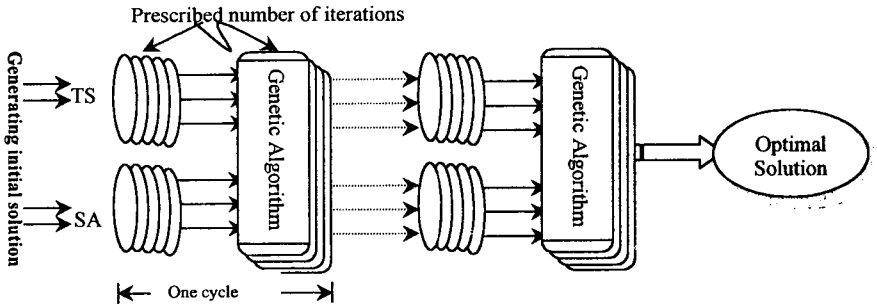

Figure 1 The structure of Hybrid-GA

In conclusion, the proposed approach, which can produce more practical layout designs and provide more flexible designs as well as providing better solution quality, will be able to be applied usefully for the optimal design of layout problems and the evaluation of relevant systems.

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