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PERFORMANCE EVALUATION OF HYBRID PROCEDURE OF SELF-ORGANIZING MAP AND SA FOR TSP

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Abstract. *As described in this paper, we propose application of a modified self-organizing map (SOM) to the traveling salesman problem (TSP), then experiment using some benchmark problems. The average CPU time using this procedure is $O(n^{2.3})$ against the number of cities n. Moreover, we propose a hybrid procedure of the modified SOM and SA. The accuracy of solutions improves the modified SOM by almost two percentages if we put the CPU time as several times the SOM process on the SA process. We show the ability to obtain an approximate solution for TSP of about tens of thousands cities with a usual PC by forecasting from the relation between computational complexity and accuracy of solutions. Moreover, tour structures of TSP are analyzed. Then we search for strategies of algorithm improvement.*

Keywords: Traveling salesman problem, Self-organizing map, Simulated annealing, Hybrid procedure, Computational complexity

1. **Introduction.** The Traveling Salesman Problem (TSP) [1], which is a typical example of a combinatorial optimization problem, is an NP-hard problem that is studied widely as the basic index for comparison of approximate performances of optimization algorithms. TSP closely relates to problems in many research fields, such as vehicle routing problem, scheduling, circuit board design, IC board design, VLSI design and so on. Development of algorithm that efficiently solves TSP brings big contribution to a great cost reduction and shortening CPU time in the above-mentioned fields.

With this problem, a combinatorial number of routes increases explosively as the number of cities increases. The CPU time eventually increases in an exponential fashion. Therefore, it is said that for a large-scale problem, quality solutions are only slightly obtainable using the simple searching method. In recent years, heuristics such as genetic algorithms (GAs) and simulated annealing (SA) [2-4] are used frequently for TSP. However, these methods present such disadvantages that it takes a longer time before an optimal solution or suboptimal solution is obtained and that setting of various parameters is very difficult.

As for neural network, three categories of Hopfield model, Kohonen model [5] and Elastic Net [6] are applied to TSP. Hopfeild model is fully connected recurrent neural networks with feedback links that seems to have dynamical complexities. Kohonen type has two-layered architecture. Elastic Net is a method of finally obtaining TSP tour by control of the parameter group, assuming a Net of rubber bands and defining an energy