The Hybrid of Ant Colony Optimization and Simulated Annealing

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1. Introduction

Ant Colony Optimization (ACO) is an optimization algorithm imitating ant’s feeding action and is effective to solve combinatorial optimization problems like the Traveling Salesman Problems (TSPs)[1]. It is well known that TSP can be solved by using various kines of Algorithms such as Genetic Algorithm (GA), Simulated Annealing (SA) and so on. However it is difficult to find the optimal solution by increasing the number of elements.

In this study, we propose the hybrid of Ant Colony Optimization and Simulated Annealing (ACOSA). ACOSA has three important features. First, ACO and SA are operated in parallel. Second, the information obtained from SA is treated as a honey which is different with a pheromone. Third, the honey affects the searching solutions of ACO. We apply ACOSA to two TSPs and confirm its effectiveness.

2. ACOSA

In ACOSA algorithm, ACO and SA make tour, respectively. The tour made by SA is similarly estimated as a pheromone and affects the search probability of ACO.

The evaluation value of the tour made by SA is called pheromone and affects the search probability of ACO. The tour made by SA is similarly estimated as a honey that this algorithm diversify search solution of ACO.

3. Numerical Experiments

In order to confirm the effectiveness of ACOSA, we apply ACOSA to two TSPs, ulysses16 and att48. The total number of the ants of ACO and ACOSA are set to the same the number of cities. We carry out the simulation 2000 iterations for 10 times. The simulation results of ACO and ACOSA are shown in Table 1. In this table, we can confirm that ACOSA obtains better result than standard ACO in both of TSPs. From this results, we consider that honey has a good effect on search solution of ACO. SA performs changing solution for the worse (adoption of a long tour) in an early stage. We consider that this algorithm diversify search solution of ACO.

Table 1: Results of ACO and ACOSA for ulysses16 and att48.

<table>
<thead>
<tr>
<th></th>
<th>ulysses16</th>
<th>att48</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACO</td>
<td>AVG 0.89%</td>
<td>2.52%</td>
</tr>
<tr>
<td></td>
<td>MIN 0.15%</td>
<td>2.30%</td>
</tr>
<tr>
<td>ACOSA</td>
<td>AVG 0.10%</td>
<td>2.19%</td>
</tr>
<tr>
<td></td>
<td>MIN 0.0%</td>
<td>0.80%</td>
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\[ \text{AVG}=(\text{Avg.tour} - \text{Optimal tour})/\text{Optimal tour} \times 100 \]
\[ \text{MIN}=(\text{Min.tour} - \text{Optimal tour})/\text{Optimal tour} \times 100 \]

4. Conclusions

In this study, we have proposed the hybrid of Ant Colony Optimization and Simulated Annealing (ACOSA). ACOSA obtained the better results than standard ACO. In particular, the minimum has been improved greatly because SA diversify search solution of ACO.

Reference