CS 312: Artificial Intelligence Laboratory
Lab 3 Report

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1 Introduction

The objective of this task is to simulate Simulated Annealing, Genetic Algorithm, and Ant Colony Optimization for the Travelling Salesman problem.

2 Analysis and Observation

2.1 Simulated Annealing

2.1.1 Perturbation Method

The solution space is perturbed by randomly swapping two cities in a tour.The method was chosen as it was the most simplest and fastest in execution while guaranteeing a different possilble solution.

2.1.2 Cooling Schedules

The various cooling schedules are listed below. Here k_{max} is the max iteration count, k is the current iteration number and T_k is temperature in k^{th} iteration.

$$T_k = k_{max}/(k+1) \tag{1}$$

$$T_k = k_{max} - k \tag{2}$$

$$T_k = 0.999^{(k)} * K_{max} \tag{3}$$

2.1.3 Results

Input	Cost of Tour Found		
	Cooling (1)	Cooling (2)	Cooling (3)
euc_100	3914.825	2729.503	2645.346
euc_250	14621.902	5859.596	5772.778
noneuc_100	6137.314	5806.287	5818.071

2.1.4 Effect of Cooling Schedules on Tour Found

It is generally observed that more gradual the cooling schedule is,the more likely it is to obtain a better tour with more optimal solution.

2.2 Genetic Algorithm

2.2.1 Representation Method

The path representation method is chosen as it is the most natural way to represent a legal tour and gives promising results.

2.2.2 Crossover Operator

Two crossover methods were explored -
(1) - Ordered Crossover: Simple and fast to implement. This method seems to be an effective way to retain information from the parents.
(2) - Cyclic crossover: It was used as it inherits the position of each city from one of the two parents as far as possible.

Order Crossover was chosen as it generally gave better results.

2.2.3 Results

Input	**Cost of Tour Found**		
	Pop size: 1000	**Pop size: 2500**	**Pop size: 5000**
euc_100	3333.838	3443.036	2853.932
euc_250	11491.703	8636.187	7761.490
noneuc_100	5738.299	5777.819	5717.235

2.2.4 Effect of Population Size on Tour Found

It is generally observed that greater the population size is,the more likely it is to obtain a better tour with a more optimal solution.

2.3 Ant Colony Optimization

2.3.1 Results

Let N represent the number of cities in the input.

Input	**Cost of Tour Found**		
	Ants = N/10	**Ants = N/5**	**Ants = N**
euc_100	1847.545	1789.104	1738.113
euc_250	3047.506	3140.045	3033.0.97
noneuc_100	5485.310	5447.986	5437.781

2.3.2 Effect of Population Size on Tour Found

It is generally observed that greater the number of ants is,the more likely it is to obtain a better tour with a more optimal solution, however, this happens at the cost of execution time.

3 Conclusion

We observe that Ant Colony Optimization gave the best results for the test cases. Simulated Annealing gave decent results and the main advantage is that it is the fastest in execution time. However, a disadvantage is that it can get stuck in a local optima. The Genetic algorithm gave decent results consistently and gave comparatively good solutions for the test case - noneuc_100. A major disadvantage is that it is really slow in execution and if the number of iterations could be increased, it would give a good solution without the ever getting stuck in a local optima. Ant Colony Optimization performed the best compared to the other two algorithms. It gave really good results within a reasonably well execution time. If given a choice, we would choose Ant Colony Optimization for solving the Travelling Salesman Problem.