## **Applied & Computational Mathematics**

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# Solving Traveling Salesmen Problem using Ant Colony Optimization Algorithm

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#### **Abstract**

Ant Colony Optimization is a new meta-heuristic technique used for solving different combinatorial optimization problems. ACO is based on the behaviors of ant colony and this method has strong robustness as well as good distributed calculative mechanism. ACO has very good search capability for optimization problems. Travelling salesman problem is one of the most famous combinatorial optimization problems. In this paper we applied the ant colony optimization technique for symmetric travelling salesperson problem. Analysis are shown that the ant select the rich pheromone distribution edge for finding out the best path.

**Keywords:** Ant colony optimization; Travelling salesman problems; Algorithm models

#### Introduction

Ant Colony Optimization (ACO) is a relatively new meta-heuristic and successful technique in the field of swarm intelligence. This technique was first introduced by Dorigo and his colleagues [1,2]. This technique is used for many applications especially problems that belong to the combinatorial optimization. ACO algorithm models represent the behavior of real ant colonies in establishing the shortest path between food sources and nests. The ants release pheromone on the ground while walking from their nest to food and then go back to the nest. The ants move according to the richer amount of pheromones on their path and other ants would be followed and will tend to choose a shorter path which would have a higher amount of pheromone. Artificial ants imitate the behavior of real ants, but can solve much more complicated problem than real ants can.

ACO has been widely applied to solving various combinatorial optimization problems such as traveling salesman problem (TSP), job-shop scheduling problem (JSP), vehicle routing problem (VRP), quadratic assignment problem (QAP), etc. [3]. Although ACO has a powerful capacity to find out solutions to combinatorial optimization problems, it has the problems of stagnation, premature convergence and the convergence speed of ACO is always slow. These problems will be more obvious when the problem size increases (Figure 1).

The traveling salesman problem (TSP) is the problem of finding a shortest closed tour which visits all the cities in a given set. In a symmetric TSP the distance between two cities is the same regardless of the direction of travel whereas in the asymmetric TSP the distance is different with regards to the direction of travel [4]. This paper restricts attention to symmetric TSPs in which cities are on a plane and a path (edge) exists between each pair of cities. The definition of a TSP is: given N cities, if a salesman starting from his home city is to visit each city exactly once and then return home, find the order of a tour such that the total distances (cost/time/money/energy etc) traveled should be minimum. A complete weighted graph G = (N, E) can be used to represent a TSP, where N is the set of n cities and E is the set of edges (paths) fully connecting all cities. Each edge  $(i,j) \in E$  is assigned a cost  $d_{ij}$ , which is the distance between cities i and j [5-7].

#### **Methodology of Ant Colon Optimization Model**

The Ant System was first introduced and applied to TSP by

Marcodorigo et al. Initially, each ant is placed on some randomly chosen city. An ant k currently at city i choose to move to city j by applying the following probabilistic transition rule:

$$p_{ij}^{k}(t) = \begin{cases} \frac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{k \in allowed_{k}} [\tau_{ik}(t)]^{\alpha}[\eta_{ik}]^{\beta}} & \text{if } j \in \text{ allowed}_{k} \\ 0 & \text{otherwise} \end{cases}$$

where n<sub>ii</sub> is the heuristic visibility of edge (i, j), generally it is a value of 1/d,, where d, is the distance between city i and city j. City J is a set of cities which remain to be visited when the ant is at city i.  $\alpha$  and  $\beta$  are two adjustable positive parameters that control the relative weights of the pheromone trail and of the heuristic visibility. If  $\alpha=0$ , the closed vertex i more likely to be selected. This is responding to a classical stochastic greedy algorithm. If  $\beta {=} 0,$  only pheromone amplification is at work: This method will lead the system to a stagnation situation, i.e. a situation in which all the ants generate a sub-optimal tour. So the trade-off between edge length and pheromone intensity is necessary. After each ant completes its tour, the pheromone amount on each path will be adjusted according to equation  $(1-\rho)$  is the pheromone decay parameter ( $0 < \rho < 1$ ) where it represents the trail evaporation when the ant chooses a city and decides to move. Number of ants represented by m,  $L_k$  is the length of the tour performed by ant k and Q is an arbitrary constant [8,9]. After all the ants complete their tour the pheromone is required to be updated using

$$\tau_{ij}(t+1) = (1-\rho)\tau_{ij}(t) + \Delta\tau_{ij}(t)$$

Where

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$$\Delta \tau_{ij}(t) = \sum_{k=1}^{m} \Delta \tau_{ij}^{k}(t)$$
Tour Length:  $\Delta \tau_{i,j}^{k} = \begin{cases} \frac{Q}{L_{k}} & \text{if } (i,j) \in \text{tour}_{k} \\ 0 & \text{oth.} \end{cases}$ 

#### Methodology

In this paper a symmetric travelling salesman problem is presented for five cities. The distance of each city is given in the Table 1 and their visibility for each edge is shown in Table 2 and 3.

#### Parameter selection

No of Ants=5

 $\alpha = 0.7$ ,  $\beta = 0.7$ , Q = 1, Number of iteration=5

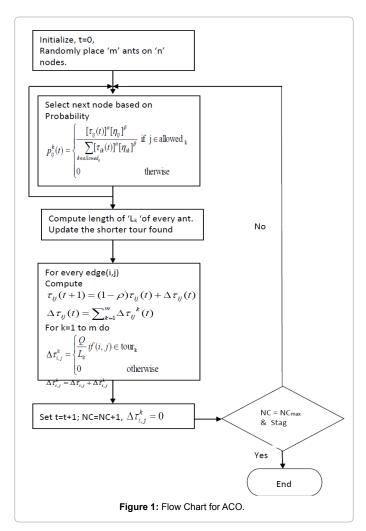
Initially pheromone ( $\tau$ ) distribution for each edge=1

#### **Results and Discussion**

Ant colony optimization methodology is presented for symmetric cities of travelling salesmen problem in this paper. A detailed procedure for city selection for respective ant is presented in the Tables 4-8 for iteration 1 to 5. The selection of next city is based on the maximum probability within the set of possible selection of the cities for next move. This is marked as '\*' in the respective iteration. In the Table 4, ant 2, 3 and 5 gives the minimum distance with the initially assumed pheromone which is one for each edge. The minimum distance remain same for the ant 2, 3 and 5 for iteration 2, however the pheromone  $(\tau)$  distribution is different because of updating the pheromone in the iteration 2 for each edge based on the updating rule. In the iteration 4, the ant 1, 2, 3 and 5 are selected the best path with minimum distance. However in the iteration 5, all the ants are converged to the minimum distance. The pheromone  $(\tau)$  distribution for iteration, 2, 3, 4 and 5 are updated for each iteration. The distribution of the pheromone  $(\tau)$  for each edge is shown in the beginning of the respective table.

Cities/ Cities	A	В	С	D	E
Α	∞	3	6	2	3
В	3	∞	5	2	3
С	6	5	∞	6	4
D	2	2	6	∞	6
E	3	3	4	6	∞

Table 1: Distance (dij) of cities.



Cities/ Cities	Α	В	С	D	E
Α	∞	0.33	0.16	0.5	0.33
В	0.33	∞	0.2	0.5	0.33
С	0.16	0.2	∞	0.16	0.25
D	0.5	0.5	0.16	∞	0.16
E	0.33	0.33	0.25	0.16	∞

Table 2: Visibility of edge = 1/dij.

Ant	1	2	3	4	5
City	Α	В	С	D	E

Table 3: Randomly select the first City by each ant.

Pheromo	ne	<u>Distrib</u> u	tion					
		City	Α	В	С	D	E	
		Α	0	1	1	1	1	
		В	1	0	1	1	1	
		С	1	1	0	1	1	
		D	1	1	1	0	1	
		E	1	1	1	1	0	
Selection	of	Citios fo	r rocno	rtivo ant				
City	Ţ	T <sup>a</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	Τ <sup>α</sup> (1/n) <sup>β</sup>	ΣΤ <sup>α</sup> (1/n) <sup>β</sup>	Probability
'	ľ	ľ	` '	ľ	,	( (-//	2 (-,,	next city
Ant 1 Pat	th							,
Selection	of	Second	City					
AB	1	1.000	3	0.3333	0.4635	0.4635	1.8278	0.2536
AC	1	1.000	6	0.1667	0.2853	0.2853	1.8278	0.1561
*AD	1	1.000	2	0.5000	0.6156	0.6156	1.8278	0.3368
AE	1	1.000	3	0.3333	0.4635	0.4635	1.8278	0.2536
Selection	of	third Cit	.y	•	•	•	•	
*DB	1	1.000	2	0.5000	0.6156	0.6156	1.1862	0.5190
DC	1	1.000	6	0.1667	0.2853	0.2853	1.1862	0.2405
DE	1	1.000	6	0.1667	0.2853	0.2853	1.1862	0.2405
Selection	of	fourth C	ity	•	•	•		
ВС	1	1.000	5	0.2000	0.3241	0.3241	0.7876	0.4115
*BE	1	1.000	3	0.3333	0.4635	0.4635	0.7876	0.5884
—								
Sele <u>ction</u>	of	last City		•	•			
Selection *EC			4	0.2500	0.3789	0.3789	0.3789	1.0000
*EC	1	1.000		0.2500 <b>B</b>	0.3789 <b>E</b>	0.3789 <b>C</b>	0.3789 <b>A</b>	1.0000
*EC Path for Distance	1 ant	1.000	4					1.0000 Total= 17
*EC Path for Distance Ant 2 Pat	1 ant th	1.000 1: A	4 D 2	В	E	С	Α	
*EC Path for Distance Ant 2 Path Selection	ant th	1.000 1: A	4 <b>D 2</b> City	B 2	E 3	C 4	A 6	Total= 17
*EC Path for Distance Ant 2 Pai Selection BA	ant th of	1.000 1: A Second 1.000	4 D 2 City 3	B 2	E 3	C 4	A 6 1.8666	Total= 17 0.2483
*EC Path for Distance Ant 2 Pai Selection BA BC	ant th of:	1.000 1: A Second 1.000 1.000	4 <b>D 2</b> City 3 5	0.3333 0.2000	0.4635 0.3241	0.4635 0.3241	A 6 1.8666 1.8666	Total= 17  0.2483  0.1736
*EC Path for Distance Ant 2 Pai Selection BA BC *BD	1 ant th of 1 1 1	1.000 1: A Second 1.000 1.000	4 D 2 City 3 5 2	0.3333 0.2000 0.5000	0.4635 0.3241 0.6156	0.4635 0.3241 0.6156	1.8666 1.8666 1.8666	0.2483 0.1736 0.3298
Path for Distance Ant 2 Par Selection BA BC *BD BE	1 ant th of 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000	4 D 2 City 3 5 2 3	0.3333 0.2000	0.4635 0.3241	0.4635 0.3241	A 6 1.8666 1.8666	Total= 17  0.2483  0.1736
Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection	1 ant th of: 1 1 1 1 of:	1.000 1: A Second 1.000 1.000 1.000 1.000 third Cit	2 City 3 5 2 3	0.3333 0.2000 0.5000 0.3333	E 3 0.4635 0.3241 0.6156 0.4635	0.4635 0.3241 0.6156 0.4635	1.8666 1.8666 1.8666	0.2483 0.1736 0.3298 0.2483
Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection *DA	1 th of 1 1 1 1 1 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000 1.000 third Cit	4 D 2 City 3 5 2 3 Y 2	0.3333 0.2000 0.5000 0.3333	0.4635 0.3241 0.6156 0.4635	0.4635 0.3241 0.6156 0.4635	1.8666 1.8666 1.8666 1.8666	Total= 17  0.2483 0.1736 0.3298 0.2483  0.5190
Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection *DA DC	1 ant th of: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000 1.000 third Cit 1.000	4 D 2 City 3 5 2 3 y 2 6	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405
Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection *DA DC DE	1 ant th of 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000 1.000 third Cit 1.000 1.000	4 D 2 City 3 5 2 3 Sy 2 6 6 6	0.3333 0.2000 0.5000 0.3333	0.4635 0.3241 0.6156 0.4635	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853	1.8666 1.8666 1.8666 1.8666	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405
Path for Distance Ant 2 Par Selection BA BC *BD BE Selection *DA DC DE Selection	1 ant th of 1 1 1 1 1 1 1 of 1 1 1 1 1 1 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000 1.000 third Cit 1.000 1.000 1.000 fourth C	4 D 2 City 3 5 2 3 3 Cy 2 6 6 6 City	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405
Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection *DA DC DE Selection AC	1 ant th of 1 1 1 1 1 1 of 1 1 1 1 1 1 1 1 1 1 1	1.000 1: A  Second 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000	4 D 2 City 3 5 2 3 Sy 2 6 6 City 6	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 1.1862 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.2405
Path for Distance Ant 2 Pai Selection *BD BE Selection DE Selection AC *AE	1	1.000 1: A Second 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000	4   D   2	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.2405
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection *DA DC DE Selection AC *AE Selection	th of 1 1 1 1 1 of 1 1 of of 1 1 1 of	1.000 1: A Second 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000	4   D   2	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 1.1862 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.3810 0.6189
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection *DA DC DE Selection AC *AE Selection *EC	1 ant th of 1 1 1 1 of 1 1 of 1 1	1.000 1: A Second 1.000	4   D   2	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.1667	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 0.7488 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.2405
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection *DA DC DE Selection AC *AE Selection *EC Path for	1 ant th of 1 1 1 1 of 1 1 of 1 ant ant	1.000 1: A Second 1.000	City 3 5 2 3 3 Y 2 6 6 6 City 6 5 3 5 City 6 5 City 7 City	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.1667	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 E	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 1.1862 0.7488 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.3810 0.6189
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection AC *AE Selection AC Path for Distance	1 ant th of 1 1 1 1 of 1 1 1 of 1 ant	1.000 1: A Second 1.000	4   D   2	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.1667	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853	0.4635 0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 0.7488 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.3810 0.6189
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection AC AC Selection AC Path for Distance Ant 3 Pai	1 ant th of 1 1 1 1 of 1 1 ant th	1.000 1: A  Second 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 2: B	City 3 5 2 3 3 Y 2 6 6 6 City 6 3 3 City 7 2 2 6 7 City 7	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.1667	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 E	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 1.1862 0.7488 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.3810 0.6189
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection AC *AE Selection AC *AE Selection AC *AE Selection Selection AC *AE Selection Selection Selection AC Selection Selection AC Selection Selection	1 ant th of 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 2.000 1.000 2.000 1.000	4   D   2	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.1667 A	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 E 3	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 1.1862 0.7488 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.2405 0.3810 0.6189 1.0000
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection AC *AE Selection AC *AE Path for Distance Ant 3 Pai Selection CA	1 ant th of: 1 1 1 of 1 1 ant th of: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 2.000 1.000	4   D   2	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.1667 A 2	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 E 3	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 1.1862 0.7488 0.7488 0.2853 B 5	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.2405 0.3810 0.6189 1.0000 Total= 16
*EC Path for Distance Ant 2 Pai Selection BA BC *BD BE Selection AC *AE Selection AC *AE Selection AC *AE Selection Selection AC *AE Selection Selection Selection AC Selection Selection AC Selection Selection	1 ant th of 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.000 1: A Second 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 2.000 1.000 2.000 1.000	4   D   2	0.3333 0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.1667 A	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 E 3	0.4635 0.3241 0.6156 0.4635 0.2853 0.2853 0.2853 0.2853 0.2853	1.8666 1.8666 1.8666 1.8666 1.1862 1.1862 1.1862 0.7488 0.7488	0.2483 0.1736 0.3298 0.2483 0.5190 0.2405 0.2405 0.3810 0.6189 1.0000

City	τ	Τ <sup>α</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	$T^{\alpha}$ (1/n) $^{\beta}$	$\Sigma T^{\alpha} (1/n)^{\beta}$	Probability o
								next city
							•	
Selection	of	third City						
*EA	1	1.000	3	0.3333	0.4635	0.4635	1.2122	0.3823
EB	1	1.000	3	0.3333	0.4635	0.4635	1.2122	0.3823
ED	1	1.000	6	0.1667	0.2853	0.2853	1.2122	0.2354
Selection	of	fourth Cit	у					
AB	1	1.000	3	0.3333	0.4635	0.4635	1.0790	0.4295
*AD	1	1.000	2	0.5000	0.6156	0.6156	1.0790	0.5705
Selection	of	ast City						
*DB	1	1.000	2	0.5000	0.6156	0.6156	0.6156	1.0000
Path for	ant	3: C	E	Α	D	В	С	
Distance			4	3	2	2	5	Total=16
Ant 4 Pa								
Selection	of S	Second Ci	_					
*DA	1	1.000	2	0.5000	0.6156	0.6156	1.8017	0.3417
DB	1	1.000	2	0.5000	0.6156	0.6156	1.8017	0.3417
DC	1	1.000	6	0.1667	0.2853	0.2853	1.8017	0.1583
DE	1	1.000	6	0.1667	0.2853	0.2853	1.8017	0.1583
Selection	oft	hird City				•		
*AB	1	1.000	3	0.3333	0.4635	0.4635	1.2122	0.3823
AC	1	1.000	6	0.1667	0.2853	0.2853	1.2122	0.2354
ΑE	1	1.000	3	0.3333	0.4635	0.4635	1.2122	0.3823
Selection	off	ourth Cit	у			•		
ВС	1	1.000	5	0.2000	0.3241	0.3241	0.7876	0.4115
*BE	1	1.000	3	0.3333	0.4635	0.4635	0.7876	0.5884
Selection	ofl	ast City		,	,			
*EC	1	1.000	4	0.2500	0.3789	0.3789	0.3789	1.0000
Path for	ant	4: D	Α	В	E	С	D	
Distance			2	3	3	4	6	Total=18
Ant 5 Pa	th							
Selection	of S	Second Ci	ty					
*EA	1	1.000	3	0.3333	0.4635	0.4635	1.5912	0.2913
EB	1	1.000	3	0.3333	0.4635	0.4635	1.5912	0.2913
EC	1	1.000	4	0.2500	0.3789	0.3789	1.5912	0.2381
LC	1	1.000	6	0.1667	0.2853	0.2853	1.5912	0.1793
ED								
ED		hird City						
ED		third City 1.000	3	0.3333	0.4635	0.4635	1.3643	0.3397
ED Selection	of		3 6	0.3333 0.1667	0.4635 0.2853	0.4635 0.2853	1.3643 1.3643	0.3397 0.2091
ED Selection AB	of 1	1.000						
ED Selection AB AC *AD	of 1 1 1	1.000	6	0.1667	0.2853	0.2853	1.3643	0.2091
ED Selection AB AC *AD	of 1 1 1 of 1	1.000 1.000 1.000	6	0.1667	0.2853	0.2853	1.3643	0.2091
Selection AB AC *AD Selection	of 1 1 1 of 1	1.000 1.000 1.000 fourth Cit	6 2 y	0.1667 0.5000	0.2853 0.6156	0.2853 0.6156	1.3643 1.3643	0.2091 0.4512
Selection  AB  AC  *AD  Selection  DC  Selection	of 1 1 1 1 1 1 1 1 1 1 1	1.000 1.000 1.000 fourth Cit 1.000 1.000	6 2 y 2	0.1667 0.5000 0.5000	0.2853 0.6156 0.6156	0.2853 0.6156 0.6156	1.3643 1.3643 0.9009	0.2091 0.4512 0.6833
Selection  AB  AC  *AD  Selection  *DB  DC	of 1 1 1 1 1 1 1 1 1 1 1	1.000 1.000 1.000 fourth Cit 1.000 1.000 ast City	6 2 y 2	0.1667 0.5000 0.5000	0.2853 0.6156 0.6156	0.2853 0.6156 0.6156	1.3643 1.3643 0.9009	0.2091 0.4512 0.6833
Selection  AB  AC  *AD  Selection  *DB  DC  Selection  *BC	1 1 1 1 1 1 1 1	1.000 1.000 1.000 fourth Cit 1.000 1.000 ast City 1.000	6 2 y 2 6	0.1667 0.5000 0.5000 0.1667 0.2000	0.2853 0.6156 0.6156 0.2853 0.3241	0.2853 0.6156 0.6156 0.2853	1.3643 1.3643 0.9009 0.9009 0.3241	0.2091 0.4512 0.6833 0.3167
Selection  AB  AC  *AD  Selection  DC  Selection	1 1 1 1 1 1 1 1	1.000 1.000 1.000 fourth Cit 1.000 1.000 ast City 1.000	6 2 y 2 6	0.1667 0.5000 0.5000 0.1667	0.2853 0.6156 0.6156 0.2853	0.2853 0.6156 0.6156 0.2853	1.3643 1.3643 0.9009 0.9009	0.2091 0.4512 0.6833 0.3167

Table 4: Iteration-1.

Pherom	one Distri	ibution	1	1	1	1	T	1
			Α	В	С	D	E	
		Α	0	0.5	0.5	0.625	0.625	
		В	0.5	0	0.5625	0.625	0.5	
		С	0.5	0.625	0	0.5	0.6875	
		D	0.5625	0.5625	0.5	0	0.5	
		E	0.5625	0.5	0.5	0.5	0	
Selectio	on of Cities		ective ar	<u>nt</u>		_		
City	T	Τ <sup>α</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	Ţ <sup>α</sup> (1/n) <sup>β</sup>	ΣŢ <sup>α</sup> (1/n) <sup>β</sup>	Probability of next city
Ant 1 P	ath .		!		!		!	or next cit
	on of Seco	nd City						
AB	0.500	0.6156	3	0.3333	0.4635	0.2853	1.2374	0.2306
AC	0.500	0.6156	6	0.1667	0.2853	0.1756	1.2374	0.1419
*AD	0.625	0.7196	2	0.5000	0.6156	0.4430	1.2374	_
AE	0.625	0.7196	3	0.3333	0.4635	0.3335	1.2374	0.2695
Selection	on of third		•	•	•	•	•	
*DB	0.563	0.6685	2	0.5000	0.6156	0.4115	0.7627	0.5395
DC	0.500	0.6156	6	0.1667	0.2853	0.1756	0.7627	0.2303
DE	0.500	0.6156	6	0.1667	0.2853	0.1756	0.7627	0.2303
Selection	on of fourt	th City				•	•	
BC	0.563	0.6685	5	0.2000	0.3241	0.2167	0.5020	0.4316
*BE	0.500	0.6156	3	0.3333	0.4635	0.2853	0.502	0.5683
Selectio	n of last C	ity				•	•	
*EC	0.500	0.6156	4	0.2500	0.3789	0.2333	0.2333	1.0000
Path fo	rant 1:	A	D	В	E	C	Α	
Distanc	е		2	2	3	4	6	Total = 17
Ant 2 P								
	n of Seco							
BA	0.5	0.6156	3	0.3333	0.4635	0.2853	1.2303	0.2319
BC	0.5625	0.6685	5	0.2000	0.3241	0.2167	1.2303	0.1761
*BD	0.625	0.7196	2	0.5000	0.6156	0.4430	1.2303	0.3601
BE	0.5	0.6156	3	0.3333	0.4635	0.2853	1.2303	0.2319
	on of third			0.5000	0.0450	h 4445	h 7027	0.500-
*DA	0.5625	0.6685	2	0.5000	0.6156	0.4115	0.7627	0.5395
DC	0.5	0.6156	6	0.1667	0.2853	0.1756	0.7627	0.2303
DE	0.5	0.6156	6	0.1667	0.2853	0.1756	0.7627	0.2303
	on of fourt		l e	0.1667	0.2052	0.1756	h E001	0 2440
AC *AE	0.5	0.6156	6 3	0.1667	0.2853	0.1756	0.5091	0.3449
	n of last C	0.7196 itv	J 3	0.3333	0.4635	0.3335	0.5091	0.6551
*EC	0.5	0.6156	4	0.2500	0.3789	0.2333	0.2333	1.0000
_	rant 2: 1		D +	0.2300 <b>A</b>	U.3763 E	0.2333 C	p.2333 B	1.0000
1 441110		_	2	2	3	4	5	Total = 16
Distanc								10101 - 10
		nd Citv						
Ant 3 P	n of Seco					Г		
	on of Secon	<del></del>	6	0.1667	0.2853	0.1756	0.8572	0.2049
Ant 3 P Selection	0.5	0.6156	6 5	0.1667 0.2000	0.2853	0.1756 0.2333	0.8572 0.8572	0.2049 0.2721
Ant 3 P Selection	1	<del></del>	6 5 6	0.1667 0.2000 0.1667	0.2853 0.3241 0.2853	0.1756 0.2333 0.1756	0.8572 0.8572 0.8572	0.2049 0.2721 0.2049

	Τ	T <sup>α</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	$T^{\alpha}$ (1/n) $^{\beta}$	Σ[ <sup>α</sup> (1/n) <sup>β</sup>	Probability of next city
Sel <u>ection</u>	of third (	City						
*EA	0.5625	0.6685	3	0.3333	0.4635	0.3098	0.7707	0.4020
EB	0.5	0.6156	3	0.3333	0.4635	0.2853	0.7707	0.3702
ED	0.5	0.6156	6	0.1667	0.2853	0.1756	0.7707	0.2279
Selection	of fourth	City			•			
AB	0.5	0.6156	3	0.3333	0.4635	0.2853	0.7283	0.3917
*AD	0.625	0.7196	2	0.5000	0.6156	0.4430	0.7283	0.6083
Selection	of last Ci	ty						
*DB	0.5625	0.6685	2	0.5000	0.6156	0.4115	0.4115	1.0000
Path for a	ant 3: C		E	Α	D	В	С	
Distance			4	3	2	2	5	Total = 16
Ant 4 Pat	h							
Selection	of Secon	d City						
*DA	0.5625	0.6685	2	0.5000	0.6156	0.4115	1.1742	0.3504
DB	0.5625	0.6685	2	0.5000	0.6156	0.4115	1.1742	0.3504
DC	0.5	0.6156	6	0.1667	0.2853	0.1756	1.1742	0.1496
DE	0.5	0.6156	6	0.1667	0.2853	0.1756	1.1742	0.1496
	of third (			• • • • • • • • • • • • • • • • • • • •			•	
AB	0.5	0.6156	3	0.3333	0.4635	0.2853	0.7944	0.3591
AC	0.5	0.6156	6	0.1667	0.2853	0.1756	0.7944	0.2211
*AE	0.625	0.7196	3	0.3333	0.4635	0.3335	0.7944	0.4198
_	of four C			-				
EC	0.5	0.6156	5	0.2000	0.3241	0.1995	0.4848	0.4115
*EB	0.5	0.6156	3	0.3333	0.4635	0.2853	0.4848	0.5885
Selection	of last Ci			•	•	•	•	•
*BC	0.5625	0.6685	4	0.2500	0.3789	0.2533	0.2533	1.0000
Dath for a	ant 4: D		Α	E	В	С	D	•
rallillidi			2	3	3	5	6	Total = 19
Distance	h							
Distance Ant 5 Pat		d City						
Distance Ant 5 Pat		d City 0.6685	3	0.3333	0.4635	0.3098	1.0040	0.3086
Distance Ant 5 Pat Selection	of Secon		3	0.3333	0.4635 0.4635	0.3098	1.0040	0.3086 0.2842
Distance Ant 5 Pat Selection *EA	of Secon	0.6685	_	_	_	+		_
Distance Ant 5 Pat Selection *EA EB	of Secon 0.5625 0.5	0.6685 0.6156	3	0.3333	0.4635	0.2853	1.0040	0.2842
Distance Ant 5 Pat Selection *EA EB EC ED	0.5625 0.5 0.5 0.5 0.5	0.6685 0.6156 0.6156 0.6156	3	0.3333 0.2500	0.4635 0.3789	0.2853 0.2333	1.0040 1.0040	0.2842 0.2323
Ant 5 Pat Selection *EA EB EC ED Selection	0.5625 0.5 0.5 0.5 0.5 of third 0	0.6685 0.6156 0.6156 0.6156	3 4 6	0.3333 0.2500 0.1667	0.4635 0.3789 0.2853	0.2853 0.2333 0.1756	1.0040 1.0040 1.0040	0.2842 0.2323 0.1749
Distance Ant 5 Pat Selection *EA EB EC ED	0.5625 0.5 0.5 0.5 0.5	0.6685 0.6156 0.6156 0.6156	3	0.3333 0.2500 0.1667	0.4635 0.3789	0.2853 0.2333 0.1756	1.0040 1.0040 1.0040	0.2842 0.2323
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB	0.5625 0.5 0.5 0.5 0.5 of third 0 0.5	0.6685 0.6156 0.6156 0.6156 0.6156	3 4 6	0.3333 0.2500 0.1667 0.3333	0.4635 0.3789 0.2853 0.4635 0.2853	0.2853 0.2333 0.1756 0.2853	1.0040 1.0040 1.0040 0.9039 0.9039	0.2842 0.2323 0.1749 0.3156
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB AC *AD	of Second 0.5625 0.5 0.5 0.5 of third 0 0.5 0.5 0.5	0.6685 0.6156 0.6156 0.6156 0.6156 0.6156 0.7196	3 4 6	0.3333 0.2500 0.1667 0.3333 0.1667	0.4635 0.3789 0.2853 0.4635	0.2853 0.2333 0.1756 0.2853 0.1756	1.0040 1.0040 1.0040 0.9039	0.2842 0.2323 0.1749 0.3156 0.1943
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB AC	of Secon 0.5625 0.5 0.5 0.5 0.5 of third 0 0.5 0.5 0.5 of thord 0 0.5 0.5	0.6685 0.6156 0.6156 0.6156 0.6156 0.6156 0.7196 City	3 4 6	0.3333 0.2500 0.1667 0.3333 0.1667 0.5000	0.4635 0.3789 0.2853 0.4635 0.2853 0.6156	0.2853 0.2333 0.1756 0.2853 0.1756 0.4430	1.0040 1.0040 1.0040 0.9039 0.9039 0.9039	0.2842 0.2323 0.1749 0.3156 0.1943 0.4901
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB AC *AD Selection	of Second 0.5625 0.5 0.5 0.5 of third 0 0.5 0.5 0.5	0.6685 0.6156 0.6156 0.6156 0.6156 0.6156 0.7196	3 4 6 3 6 2	0.3333 0.2500 0.1667 0.3333 0.1667 0.5000	0.4635 0.3789 0.2853 0.4635 0.2853	0.2853 0.2333 0.1756 0.2853 0.1756	1.0040 1.0040 1.0040 0.9039 0.9039	0.2842 0.2323 0.1749 0.3156 0.1943
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB AC *AD Selection *DB DC	of Second 0.5625 0.5 0.5 0.5 of third 0 0.5 0.625 of fourth 0.5625	0.6685 0.6156 0.6156 0.6156 0.6156 0.6156 0.7196 City 0.6685 0.6156	3 4 6 3 6 2	0.3333 0.2500 0.1667 0.3333 0.1667 0.5000	0.4635 0.3789 0.2853 0.4635 0.2853 0.6156	0.2853 0.2333 0.1756 0.2853 0.1756 0.4430	1.0040 1.0040 1.0040 0.9039 0.9039 0.9039 0.5871	0.2842 0.2323 0.1749 0.3156 0.1943 0.4901 0.7009
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB AC *AD Selection *DB DC Selection	of Second 0.5625 0.5 0.5 0.5 of third 0 0.5 0.625 of fourth 0.5625	0.6685 0.6156 0.6156 0.6156 0.6156 0.6156 0.7196 City 0.6685 0.6156	3 4 6 3 6 2	0.3333 0.2500 0.1667 0.3333 0.1667 0.5000	0.4635 0.3789 0.2853 0.4635 0.2853 0.6156	0.2853 0.2333 0.1756 0.2853 0.1756 0.4430	1.0040 1.0040 1.0040 0.9039 0.9039 0.9039 0.5871	0.2842 0.2323 0.1749 0.3156 0.1943 0.4901 0.7009
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB AC *AD Selection *DB DC Selection *BC	of Second 0.5625 0.5 0.5 0.5 of third ( 0.5 0.625 of fourth 0.5625 of last Ci 0.5625	0.6685 0.6156 0.6156 0.6156 0.6156 0.6156 0.6156 0.7196 City 0.6685 0.6156	3 4 6 3 6 2	0.3333 0.2500 0.1667 0.3333 0.1667 0.5000 0.5000 0.1667	0.4635 0.3789 0.2853 0.4635 0.2853 0.6156 0.2853	0.2853 0.2333 0.1756 0.2853 0.1756 0.4430 0.4115 0.1756	1.0040 1.0040 1.0040 0.9039 0.9039 0.9039 0.5871 0.5871	0.2842 0.2323 0.1749 0.3156 0.1943 0.4901 0.7009 0.2991
Distance Ant 5 Pat Selection *EA EB EC ED Selection AB AC *AD Selection *DB DC Selection	of Second 0.5625 0.5 0.5 0.5 of third ( 0.5 0.625 of fourth 0.5625 of last Ci 0.5625	0.6685 0.6156 0.6156 0.6156 0.6156 0.6156 0.6156 0.7196 City 0.6685 0.6156	3 4 6 3 6 2 2 6	0.3333 0.2500 0.1667 0.3333 0.1667 0.5000 0.1667	0.4635 0.3789 0.2853 0.4635 0.2853 0.6156 0.2853	0.2853 0.2333 0.1756 0.2853 0.1756 0.4430 0.4115 0.1756	1.0040 1.0040 1.0040 0.9039 0.9039 0.9039 0.5871 0.5871	0.2842 0.2323 0.1749 0.3156 0.1943 0.4901 0.7009 0.2991

Table 5: Iteration-2.

Pheron	none distril	oution						
			Ι ,	ь	С		г	
		٨	A 0	0.25	0.25	D 0.4375	E 0.4375	
		A	0.25	0.23	0.34375	0.4375	0.4373	
		B C	0.25	0.4375	0.34373	0.4373	0.53125	
		D	0.34375	0.4373	0.25	0.23	0.33123	
		E	0.34375	0.25	0.25	0.25	0.23	
		L	0.5 1575	0.23	0.23	0.23	v	
	of Cities f		T	1	1 .	l	- 0	
City		T <sup>α</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	Ţ <sup>α</sup> (1/n) <sup>ρ</sup>	ΣΤ <sup>α</sup> (1/n) <sup>β</sup>	Probability of next city
Ant 1 Pa	th				-	!		
Selection	n of Second	l City						
AB	0.25	0.3789	3	0.3333	0.4635	0.1756	0.8887	0.1976
AC	0.25	0.3789	6	0.1667	0.2853	0.1081	0.8887	0.1216
*AD	0.4375	0.5606	2	0.5000	0.6156	0.3451	0.8887	0.3883
AE	0.4375	0.5606	3	0.3333	0.4635	0.2598	0.8887	0.2924
Selection	of third C	ity						
*DB	0.4375	0.5606	2	0.5000	0.6156	0.3451	0.5613	0.6148
DC	0.25	0.3789	6	0.1667	0.2853	0.1081	0.5613	0.1926
DE	0.25	0.3789	6	0.1667	0.2853	0.1081	0.5613	0.1926
Selection	of fourth	City	!		•	!		
BC	0.3438	0.4736	5	0.2000	0.3241	0.1535	0.3291	0.4664
*BE	0.25	0.3789	3	0.3333	0.4635	0.1756	0.3291	0.5336
Selection	n of last Cit	у						
*EC		0.6423	4	0.2500	0.3789	0.2434	0.2434	1.0000
Path for	ant 1: /	4	В	E	С			
Distance	<u>:</u>		2	2	3	4	6	Total = 17
Ant 2 Pa	th							
Selection	n of Second	l City						
BA	0.25	0.3789	3	0.3333	0.4635	0.1756	0.8499	0.2066
ВС	0.3438	0.4736	5	0.2000	0.3241	0.1535	0.8499	0.1806
	0.4275							
*BD	1 0.43/5	0.5606	2	0.5000	0.6156	0.3451	0.8499	0.4061
*BD BE	0.4375		3	0.5000 0.3333	0.6156 0.4635	0.3451 0.1756	0.8499 0.8499	0.4061 0.2066
BE		0.3789			_			
BE	0.25 n of third C	0.3789			0.4635			
BE Selection	0.25 n of third C 0.4375	0.3789 ity	3	0.3333	0.4635	0.1756	0.8499	0.2066
BE Selection *DA	0.25 n of third C 0.4375	0.3789 ity 0.5606 0.3789	3	0.3333	0.4635 0.6156 0.2853	0.1756	0.8499	0.2066
BE Selection *DA DC DE	0.25 n of third C 0.4375 0.25 0.25	0.3789 ity 0.5606 0.3789 0.3789	3 2 6	0.3333 0.5000 0.1667	0.4635 0.6156 0.2853	0.1756 0.3451 0.1081	0.8499 0.5613 0.5613	0.2066 0.6148 0.1926
Selection  *DA  DC  DE  Selection	0.25 n of third C 0.4375 0.25 0.25	0.3789 ity 0.5606 0.3789 0.3789	3 2 6	0.3333 0.5000 0.1667	0.4635 0.6156 0.2853 0.2853	0.1756 0.3451 0.1081	0.8499 0.5613 0.5613	0.2066 0.6148 0.1926
BE Selection *DA DC DE	0.25 n of third C 0.4375 0.25 0.25 n of fourth	0.3789 ity 0.5606 0.3789 0.3789 City	3 2 6 6	0.3333 0.5000 0.1667 0.1667	0.4635 0.6156 0.2853 0.2853	0.1756 0.3451 0.1081 0.1081	0.8499 0.5613 0.5613 0.5613	0.2066 0.6148 0.1926 0.1926
Selection  *DA  DC  DE  Selection  AC  *AE	0.25 n of third C 0.4375 0.25 0.25 n of fourth	0.3789 ity 0.5606 0.3789 0.3789 City 0.3789 0.5606	3 2 6 6	0.3333 0.5000 0.1667 0.1667	0.4635 0.6156 0.2853 0.2853 0.2853	0.1756 0.3451 0.1081 0.1081 0.1081	0.8499 0.5613 0.5613 0.5613	0.2066 0.6148 0.1926 0.1926 0.2938
Selection  *DA  DC  DE  Selection  AC  *AE  Selection	0.25 n of third C 0.4375 0.25 0.25 0.25 n of fourth 0.25 0.4375 n of last Cit	0.3789 ity 0.5606 0.3789 0.3789 City 0.3789 0.5606	3 2 6 6	0.3333 0.5000 0.1667 0.1667 0.1667 0.3333	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635	0.1756 0.3451 0.1081 0.1081 0.1081 0.2598	0.5613 0.5613 0.5613 0.3679	0.2066 0.6148 0.1926 0.1926 0.2938 0.7063
Selection  *DA DC DE Selection AC *AE Selection *EC	0.25 n of third C 0.4375 0.25 0.25 0.25 n of fourth 0.25 0.4375 n of last Cit 0.5313	0.3789 ity 0.5606 0.3789 0.3789 City 0.3789 0.5606	3 2 6 6 6	0.3333 0.5000 0.1667 0.1667	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635	0.1756 0.3451 0.1081 0.1081 0.1081	0.8499 0.5613 0.5613 0.5613	0.2066 0.6148 0.1926 0.1926 0.2938
Selection  *DA DC DE Selection  *AC *AE Selection  *EC Path for	0.25 n of third C 0.4375 0.25 0.25 0.25 n of fourth 0.25 0.4375 n of last Cit 0.5313 ant 2:	0.3789 ity 0.5606 0.3789 0.3789 City 0.3789 0.5606 y	3 2 6 6 6 3	0.3333 0.5000 0.1667 0.1667 0.1667 0.3333	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635	0.1756 0.3451 0.1081 0.1081 0.1081 0.2598	0.8499 0.5613 0.5613 0.5613 0.3679 0.3679 0.2434 B	0.2066 0.6148 0.1926 0.1926 0.2938 0.7063
Selection  *DA  DC  DE  Selection  *AE  Selection  *EC  Path for  Distance	0.25 n of third C   0.4375   0.25   0.25   0.25   0.25   0.4375   0.25   0.4375   0.4375   0.5313   ant 2:	0.3789 ity 0.5606 0.3789 0.3789 City 0.3789 0.5606 y	3 2 6 6 6 3	0.3333 0.5000 0.1667 0.1667 0.1667 0.3333 0.2500 A	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E	0.1756 0.3451 0.1081 0.1081 0.1081 0.2598 0.2434 C	0.8499 0.5613 0.5613 0.5613 0.3679 0.3679 0.2434 B	0.2066 0.6148 0.1926 0.1926 0.2938 0.7063
Selection  *DA  DC  DE  Selection  AC  *AE  Selection  *EC  Path for  Distance  Ant 3 Pa	0.25 n of third C   0.4375   0.25   0.25   0.25   0.25   0.4375   0.25   0.4375   0.5313   ant 2:	0.3789 ity 0.5606 0.3789 0.3789 City 0.3789 0.5606 y 0.6423	3 2 6 6 6 3	0.3333 0.5000 0.1667 0.1667 0.1667 0.3333 0.2500 A	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E	0.1756 0.3451 0.1081 0.1081 0.1081 0.2598 0.2434 C	0.8499 0.5613 0.5613 0.5613 0.3679 0.3679 0.2434 B	0.2066 0.6148 0.1926 0.1926 0.2938 0.7063
Selection  *DA DC DE Selection AC *AE Selection  *EC Path for Distance Ant 3 Pa Selection	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.4375 0.25 0.4375 0.5313 ant 2:	0.3789 ity 0.5606 0.3789 0.3789 0.3789 0.5606 y 0.6423	3 2 6 6 6 3 4 D 2	0.3333 0.5000 0.1667 0.1667 0.3333 0.2500 A 2	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E 3	0.1756 0.3451 0.1081 0.1081 0.1081 0.2598 0.2434 <b>C</b> <b>4</b>	0.8499 0.5613 0.5613 0.3679 0.3679 0.2434 B 5	0.2066 0.6148 0.1926 0.1926 0.2938 0.7063 1.0000 Total = 16
Selection  *DA DC DE Selection  *AE Selection  *EC Path for Distance Ant 3 Pa Selection CA	0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.4375 0.375 0.375 0.4375 0.5313 ant 2:	0.3789 ity 0.5606 0.3789 0.3789 0.3789 0.5606 y 0.6423 B	3 2 6 6 3 4 D 2	0.3333 0.5000 0.1667 0.1667 0.3333 0.2500 A 2	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E 3	0.1756  0.3451 0.1081 0.1081 0.1081 0.2598  0.2434	0.8499 0.5613 0.5613 0.5613 0.3679 0.3679 0.2434 B 5	0.2066  0.6148  0.1926  0.1926  0.2938  0.7063  1.0000  Total = 16
Selection  *DA DC DE Selection AC *AE Selection  *EC Path for Distance Ant 3 Pa Selection	0.25 n of third C   0.4375   0.25 n of fourth   0.25 n of fourth   0.25   0.4375 n of last Cit   0.5313   ant 2:   th n of Second   0.25   0.4375   0.4375   0.4375   0.4375   0.4375   0.4375   0.4375   0.4375   0.4375	0.3789 ity 0.5606 0.3789 0.3789 0.3789 0.5606 y 0.6423	3 2 6 6 6 3 4 D 2	0.3333 0.5000 0.1667 0.1667 0.3333 0.2500 A 2	0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E 3	0.1756 0.3451 0.1081 0.1081 0.1081 0.2598 0.2434 <b>C</b> <b>4</b>	0.8499 0.5613 0.5613 0.3679 0.3679 0.2434 B 5	0.2066  0.6148 0.1926 0.1926 0.2938 0.7063  1.0000  Total = 16

Ι,	City T	Ţ <sup>α</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	Ţ <sup>α</sup> (1/n) <sup>β</sup>	$\Sigma T^{\alpha} (1/n)^{\beta}$	Probability
								of next city
Coloc	tion of third	City						
*E		0.5606	3	0.3333	0.4635	0.2598	0.5436	0.4780
EB	_	0.3789	3	0.3333	0.4635	0.1756	0.5436	0.3231
ED	_	0.3789	6	0.1667	0.2853	0.1081	0.5436	0.1989
_	tion of fourt		<u> </u>	0.2007	0.2033	0.1001	0.5 150	0.1303
AB		0.3789	3	0.3333	0.4635	0.1756	0.5207	0.3373
*A		0.5606	2	0.5000	0.6156	0.3451	0.5207	0.6628
C-1								
Select *D	tion of last C B 0.4375		2	0.5000	0.6156	0.3451	0.3451	1.0000
Path f	or ant 3:	С	E	Α	D	В	С	
Distan	ce		4	3	2	2	5	Total = 16
Ant 4	Path							
Select	ion of Secon	d City						
*D	A 0.3438	0.4736	2	0.5000	0.6156	0.2915	0.7993	0.3647
DB	0.3438	0.4736	2	0.5000	0.6156	0.2915	0.7993	0.3647
DC	0.25	0.3789	6	0.1667	0.2853	0.1081	0.7993	0.1353
DE	0.25	0.3789	6	0.1667	0.2853	0.1081	0.7993	0.1353
	ion of third	City					·	
AB	0.25	0.3789	3	0.3333	0.4635	0.1756	0.5032	0.3490
AC			6	0.1667	0.2853	0.1081	0.5032	0.2148
*A			3	0.3333	0.4635	0.2195	0.5032	0.4362
	ion of fourtl							
EC		0.3789	5	0.2000	0.3241	0.1228	0.2984	0.4115
*El		0.3789	3	0.3333	0.4635	0.1756	0.2984	0.5885
	ion of last C					<u> </u>		
*B		0.5606	4	0.2500	0.3789	0.2124	0.2124	1.0000
	or ant 4:	D	A	E	В	C	D	
Distan			2	3	3	5	6	Total = 19
Ant 5		٦ C:۳.						
select *E/	ion of Secon	0.4736	3	0.3333	0.4635	0.2195	0.7365	0.2980
EB	_		3	0.3333	0.4635	0.2195	0.7365	0.2385
		0.5765	4	0.2500	0.4033	0.1730	0.7365	0.2363
_		0.0130	7	0.2300	0.5763	0.2333		0.3107
EC		0 3789	6	0 1667	n 2853	0 1081	0.73651	
EC ED	0.25	0.3789 City	6	0.1667	0.2853	0.1081	0.7365	0.1400
EC ED Select	0.25	City			!			
EC ED Select AB	0.25 ion of third 0.25	City 0.3789	3	0.3333	0.4635	0.1756	0.5753	0.3053
EC ED Select AB	0.25 ion of third 0.25 0.25	0.3789 0.3789	3 6	0.3333 0.1667	0.4635 0.2853	0.1756 0.1081	0.5753 0.5753	0.3053 0.1879
EC ED Select AB AC *A	0.25 ion of third 0.25 0.25	0.3789 0.3789 0.4736	3	0.3333	0.4635	0.1756	0.5753	0.3053
EC ED Select AB AC *A	0.25 ion of third 0.25 0.25 0.25 0.3438 ion of fourth	0.3789 0.3789 0.4736 0.4736	3 6 2	0.3333 0.1667 0.5000	0.4635 0.2853 0.6156	0.1756 0.1081	0.5753 0.5753	0.3053 0.1879 0.5068
EC ED Select AC *A Select	0.25 ion of third 0.25 0.25 0.25 0.3438 ion of fourth 0.3438	0.3789 0.3789 0.4736 0.4736	3 6	0.3333 0.1667 0.5000 0.5000	0.4635 0.2853 0.6156	0.1756 0.1081 0.2915	0.5753 0.5753 0.5753	0.3053 0.1879 0.5068 0.7295
EC ED Select AB AC *A Select *D	0.25 ion of third 0.25 0.25 0.25 0.3438 ion of fourth B 0.3438 0.25	0.3789 0.3789 0.4736 0.4736 0.4736 0.3789	3 6 2	0.3333 0.1667 0.5000	0.4635 0.2853 0.6156	0.1756 0.1081 0.2915 0.2915	0.5753 0.5753 0.5753 0.3996	0.3053 0.1879 0.5068
EC ED Select AB AC *A Select *D	0.25 ion of third 0.25 0.25 0.25 0.3438 ion of fourth B 0.3438 0.25 ion of last C	0.3789 0.3789 0.4736 0.4736 0.4736 0.3789	3 6 2	0.3333 0.1667 0.5000 0.5000 0.1667	0.4635 0.2853 0.6156 0.6156 0.2853	0.1756 0.1081 0.2915 0.2915	0.5753 0.5753 0.5753 0.3996	0.3053 0.1879 0.5068 0.7295
ECC ED AB ACC *A *A *D DCC *B	0.25 ion of third 0.25 0.25 0.25 0.3438 ion of fourtl 0.3438 0.25 ion of last C	0.3789 0.3789 0.4736 0.4736 0.4736 0.3789	3 6 2	0.3333 0.1667 0.5000 0.5000 0.1667	0.4635 0.2853 0.6156 0.6156 0.2853	0.1756 0.1081 0.2915 0.2915 0.1081	0.5753 0.5753 0.5753 0.5753 0.3996 0.3996	0.3053 0.1879 0.5068 0.7295 0.2705

Table 6: Iteration-3.

Pne	eromo	one distrib	oution						
		į		A	В	С	D	E	
			A	0	0.25	0.25	0.4375	0.4375	
			В	0.25	0.23	0.34375	0.4375	0.4373	
			С	0.25	0.4375	0.54575	0.4373	0.53125	
			D	0.34375	0.34375	0.25	0.23	0.25	
			E	0.34375	0.25	0.25	0.25	0	
				<u> </u>					
	City	of Cities f	or respec	Cost(n)	1/n	(1/n) <sup>β</sup>	Τ <sup>α</sup> (1/n) <sup>β</sup>	ΣΤ <sup>α</sup> (1/n) <sup>β</sup>	Probability
						` ' '	` ` ' '	[ ( , ,	of next city
<b>L</b> Ant 1	1 Pat	h							Of HEAT CIT
		of Second	City						
-	AB		0.3789	3	0.3333	0.4635	0.1756	0.8887	0.1976
- 1	AC		0.3789	6	0.1667	0.2853	0.1081	0.8887	0.1216
- 1	*AD		0.5606	2	0.5000	0.6156	0.3451	0.8887	0.3883
- 1	AE		0.5606	3	0.3333	0.4635	0.2598	0.8887	0.2924
L	_	of third C		<u> </u>		1	1	2,000,	
_	*DB		0.5606	2	0.5000	0.6156	0.3451	0.5613	0.6148
	DC		0.3789	6	0.1667	0.2853	0.1081	0.5613	0.1926
-	DE	0.25	0.3789	6	0.1667	0.2853	0.1081	0.5613	0.1926
<b>ـ</b> Seled	ction	of fourth	City						
	BC		0.4736	5	0.2000	0.3241	0.1535	0.3291	0.4664
- 1	*BE		0.3789	3	0.3333	0.4635	0.1756	0.3291	0.5336
L		of last Cit			0.0000	01.000	0.17.00	0.0201	0.0000
_	*EC		0.6423	4	0.2500	0.3789	0.2434	0.2434	1.0000
L	for a			В	E	С	A		
Dista	ance			2	2	3	4	6	Total = 17
Ant 2	2 Patl	h							
Selec	ction	of Second	l City						
	ВА		0.3789	3	0.3333	0.4635	0.1756	0.8499	0.2066
ı	ВС	0.3438	0.4736	5	0.2000	0.3241	0.1535	0.8499	0.1806
ı	*BD	0.4375	0.5606	2	0.5000	0.6156	0.3451	0.8499	0.4061
ı	BE	0.25	0.3789	3	0.3333	0.4635	0.1756	0.8499	0.2066
Seled	ction	of third C	ity	-	•	•	•		
ſ	*DA	0.4375	0.5606	2	0.5000	0.6156	0.3451	0.5613	0.6148
ı	DC	0.25	0.3789	6	0.1667	0.2853	0.1081	0.5613	0.1926
ı	DE	0.25	0.3789	6	0.1667	0.2853	0.1081	0.5613	0.1926
Selec	ction	of fourth	City			•			
Ţ	AC	0.25	0.3789	6	0.1667	0.2853	0.1081	0.3679	0.2938
ı	*AE	0.4375	0.5606	3	0.3333	0.4635	0.2598	0.3679	0.7063
Selec	ction	of last Cit	у		•		•	•	
ſ	*EC	0.5313	0.6423	4	0.2500	0.3789	0.2434	0.2434	1.0000
Path	for a	nt 2:	В	D	Α	E	С	В	
Dista	ance			2	2	3	4	5	Total = 16
Ant 3	3 Patl	h							
Seled	ction	of Second	l City						
	CA	0.25	0.3789	6	0.1667	0.2853	0.1081	0.6413	0.1686
Ī	СВ	0.4375	0.5606	5	0.2000	0.3241	0.1817	0.6413	0.2834
ı	CD	0.25	0.3789	6	0.1667	0.2853	0.1081	0.6413	0.1686
			0.6423		0.2500	0.3789	0.2434	0.6413	0.3795

City	Ţ	Ţ <sup>α</sup>	Cost(n	1/n	(1/n) <sup>β</sup>	Ţ <sup>α</sup> (1/n) <sup>β</sup>	$\sum T^{\alpha} (1/n)^{\beta}$	Probability
								of next city
Selection	of third	City						
*EA		0.5606	3	0.3333	0.4635	0.2598	0.5436	0.4780
EB		0.3789	3	0.3333	0.4635	0.1756	0.5436	0.3231
ED		0.3789	6	0.1667	0.2853	0.1081	0.5436	0.1989
	of fourt		_ •	0.2007	0.2000	0.2002	0.0.00	0.2505
AB		0.3789	3	0.3333	0.4635	0.1756	0.5207	0.3373
*AD		0.5606	2	0.5000	0.6156	0.3451	0.5207	0.6628
Selectior *DB	0.4375		2	0.5000	0.6156	0.3451	0.3451	1.0000
Path for a	-	C.	E	A	D	B	C	1.0000
Distance		•	4	3	2	2	5	Total = 16
Ant 4 Pat	h							
Selection	of Secon	d Citv						
*DA		0.4736	2	0.5000	0.6156	0.2915	0.7993	0.3647
DB		0.4736	2	0.5000	0.6156	0.2915	0.7993	0.3647
DC		0.3789	6	0.1667	0.2853	0.1081	0.7993	0.1353
DE	0.25	0.3789	6	0.1667	0.2853	0.1081	0.7993	0.1353
	of third	City						
AB		0.3789	3	0.3333	0.4635	0.1756	0.5032	0.3490
AC		0.3789	6	0.1667	0.2853	0.1081	0.5032	0.2148
*AE	0.3438	0.4736	3	0.3333	0.4635	0.2195	0.5032	0.4362
Selection	of fourth	City						
EC	0.25		5	0.2000	0.3241	0.1228	0.2984	0.4115
*EB	0.25	0.3789	3	0.3333	0.4635	0.1756	0.2984	0.5885
Selection	of last C	ity			•	!!	-	
*BC	0.4375	0.5606	4	0.2500	0.3789	0.2124	0.2124	1.0000
Path for a	nt 4:	D	Α	E	В	С	D	
Distance			2	3	3	5	6	Total = 19
Ant 5 Pat	th							
Selection	of Secon	d City						
*EA	0.3438	0.4736	3	0.3333	0.4635	0.2195	0.7365	0.2980
EB	0.25	0.3789	3	0.3333	0.4635	0.1756	0.7365	0.2385
EC	0.5	0.6156	4	0.2500	0.3789	0.2333	0.7365	0.3167
ED	0.25	0.3789	6	0.1667	0.2853	0.1081	0.7365	0.1468
Selection								
	0.25	0.3789	3	0.3333	0.4635	0.1756	0.5753	0.3053
AC		0.3789	6	0.1667	0.2853	0.1081	0.5753	0.1879
*AD	0.3438		2	0.5000	0.6156	0.2915	0.5753	0.5068
Selection								
*DB	0.3438	0.4736	2	0.5000	0.6156	0.2915	0.3996	0.7295
DC	0.25	0.3789	6	0.1667	0.2853	0.1081	0.3996	0.2705
Selection								
*BC	0.4375	0.5606	5	0.2000	0.3241	0.1817	0.1817	1.0000
Path for a	ant 5:	E	Α	D	В	С	E	

Table 7: Iteration-4.

				Α	В	С	D	E	
			Α	0	0.0625	0.0625	0.3594	0.2969	
			В	0.0625	0	0.2422	0.3594	0.0625	
			С	0.0625	0.2969	0	0.0625	0.4141	
			D	0.1797	0.1797	0.0625	0	0.0625	
			E	0.2422	0.0625	0.125	0.0625	0	
Sele	ection	of Cities	for respe	ctive ant					
	City	Ţ	Ţ <sup>α</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	Ţ <sup>α</sup> (1/n) <sup>β</sup>	ΣΤ <sup>α</sup> (1/n) <sup>β</sup>	Probability of next cit
Λn+	1 Pat	h		!				ļ	
		of Secon	od City						
Dele			0.1436	3	0.3333	0.4635	0.0665	0.6063	0.1098
	_	_	0.1436	6	0.3333	0.4633	0.0665	0.6063	0.1098
	_		0.1430	2	0.5000	0.6156	0.3007	0.6063	0.4960
	_	0.3394	0.4663	3	0.3333	0.4635	0.3007	0.6063	0.4900
ر مام	$\overline{}$	of third			0.000	10.7033	0.1301	0.0003	0.3207
اداد	_	0.3594	0.4885	2	0.5000	0.6156	0.3007	0.3826	0.7859
	$\vdash$	0.0625	0.1436	6	0.1667	0.2853	0.0410	0.3826	0.1071
	_	0.0625	0.1436	6	0.1667	0.2853	0.0410	0.3826	0.1071
Sele		of fourth			0.1007	0.2033	0.0410	0.3020	0.1071
JCIC	$\overline{}$	0.2342	0.3620	5	0.2000	0.3241	0.1173	0.1839	0.6381
	BE	0.0625	0.1436	3	0.3333	0.4635	0.0665	0.1839	0.3619
	DL	0.0023	0.1430		0.5555	0.4033	0.0003	0.1033	0.3013
	*CF	0.1250	0.2333	4	0.2500	0.3789	0.0884	0.0884	1.0000
Path	<u> </u>	nt 1:	A		В	С	E	A	
Dist	ance			2	2	5	4	3	Total = 16
	2 Pat	h							
Sele	ection	of Secon	nd City						
	ВА	0.0625	0.1426	1	0.3333	0.4635	0.0665	0.5539	0.4304
	D/A	0.0023	0.1430	3	0.5555	0.7033	0.0003	0.5555	0.1201
			0.1436	5	0.2000	0.3241	0.1201	0.5539	0.1201
	ВС	0.2422							0.2169
	ВС	0.2422	0.3706	5	0.2000	0.3241	0.1201	0.5539	0.2169
Sele	BC *BD BE	0.2422 0.3594	0.3706 0.4885 0.1436	5	0.2000 0.5000	0.3241 0.6156	0.1201 0.3007	0.5539 0.5539	0.2169 0.5429
Sele	BC *BD BE ection	0.2422 0.3594 0.0625	0.3706 0.4885 0.1436 City	5	0.2000 0.5000	0.3241 0.6156	0.1201 0.3007	0.5539 0.5539	0.2169 0.5429
Sele	BC *BD BE ection *DA	0.2422 0.3594 0.0625 of third 0.3594	0.3706 0.4885 0.1436 City	5 2 3	0.2000 0.5000 0.3333	0.3241 0.6156 0.4635	0.1201 0.3007 0.0665	0.5539 0.5539 0.5539	0.2169 0.5429 0.1201 0.7859
Sele	BC *BD BE ection *DA DC	0.2422 0.3594 0.0625 of third 0.3594	0.3706 0.4885 0.1436 City 0.4885	5 2 3	0.2000 0.5000 0.3333 0.5000	0.3241 0.6156 0.4635 0.6156	0.1201 0.3007 0.0665 0.3007	0.5539 0.5539 0.5539 0.3826	0.2169 0.5429 0.1201 0.7859
	*BD BE ection *DA DC DE	0.2422 0.3594 0.0625 of third 0.3594 0.0625	0.3706 0.4885 0.1436 City 0.4885 0.1436	5 2 3 2 6 6	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410	0.5539 0.5539 0.5539 0.3826	0.2169 0.5429 0.1201 0.7859 0.1071
Sele	BC *BD BE ection *DA DC DE	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth	0.3706 0.4885 0.1436 City 0.4885 0.1436	5 2 3 2 6 6	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.3241 0.6156 0.4635 0.6156 0.2853	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826	0.2169 0.5429 0.1201 0.7859 0.1071
Sele	BC *BD BE ection DC DE ection AC	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436	5 2 3 2 6 6	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071
Sele	BC *BD BE ection *DA DC DE ection AC *AE	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.1436 0.4274	5 2 3 2 6 6	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071
Sele	BC *BD BE ection DC DE ection AC *AE	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth 0.0625 0.2969	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.1436 0.4274	5 2 3 2 6 6	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071
Sele Sele	BC *BD BE ection *DA DC DE ection AC *AE ection	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth 0.0625 0.2969 of last Ci	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.1436 0.4274	5 2 3 2 6 6 6	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410 0.0410 0.1981	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826 0.2390	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071 0.1714 0.8287
Sele Sele Patl	BC *BD BE ection *DA DC DE ection AC *AE ection	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth 0.0625 0.2969 of last Ci	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.4274 ity 0.5394	5 2 3 2 6 6 6	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.2500	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853 0.4635	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410 0.0410 0.1981	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826 0.2390 0.2390	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071 0.1714 0.8287
Sele Sele Path Dist Ant	BC *BD BE ection *DA DC DE ection AC *AE ection *EC ance 3 Pat	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth 0.0625 0.2969 of last Ci 0.4141 ant 2:	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.4274 ity 0.5394 B	5 2 3 6 6 6 3	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.2500 A	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410 0.0410 0.1981 0.2044 C	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826 0.2390 0.2390	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071 0.1714 0.8287
Sele Sele Path Dist Ant	BC *BD BE ection *DA DC DE ection AC *AE ection *TEC 3 Pat	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth 0.0625 0.2969 of last Ci 0.4141 ant 2:	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.1436 0.4274 ity 0.5394 B	5 2 3 2 6 6 6 3 4 D 2	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.2500 A 2	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E 3	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410 0.0410 0.1981 0.2044 C 4	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826 0.2390 0.2390 0.2044 B 5	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071 0.1714 0.8287 1.0000
Sele Sele Patl Dist Ant	BC *BD BE ection *DA DC DE ection AC *AE ection *Gance 3 Pat	0.2422 0.3594 0.0625 0.3594 0.0625 0.0625 of fourth 0.0625 0.2969 of last Ci 0.4141 ant 2:	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.4274 ity 0.5394 B	5 2 3 6 6 6 3 4 D 2	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.2500 A 2	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E 3	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410 0.0410 0.1981 0.2044 C 4	0.5539 0.5539 0.5539 0.5539 0.3826 0.3826 0.2390 0.2390 0.2044 B 5	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071 0.1714 0.8287 1.0000 Total = 16
Sele Sele Patl Dist Ant	BC *BD BE ection *DA DC DE ection AC *AE ection *EC h for a cance 3 Pat ection CA CB	0.2422 0.3594 0.0625 of third 0.3594 0.0625 0.0625 of fourth 0.0625 0.2969 of last Ci 0.4141 ant 2:	0.3706 0.4885 0.1436 City 0.4885 0.1436 0.1436 0.1436 0.1436 0.1436 0.4274 ity 0.5394 B	5 2 3 2 6 6 6 3 4 D 2	0.2000 0.5000 0.3333 0.5000 0.1667 0.1667 0.3333 0.2500 A	0.3241 0.6156 0.4635 0.6156 0.2853 0.2853 0.2853 0.4635 0.3789 E 3	0.1201 0.3007 0.0665 0.3007 0.0410 0.0410 0.0410 0.1981 0.2044 C 4	0.5539 0.5539 0.5539 0.3826 0.3826 0.3826 0.2390 0.2390 0.2044 B 5	0.2169 0.5429 0.1201 0.7859 0.1071 0.1071 0.1714 0.8287 1.0000

City	Ţ	Ţ <sup>α</sup>	Cost(n)	1/n	(1/n) <sup>β</sup>	$T^{\alpha} (1/n)^{\beta}$	$\sum T^{\alpha} (1/n)^{\beta}$	Probability
								of next cit
Coloction	of third C	itv						
Selection (	0.2969	0.4274	3	0.3333	0.4635	0.1981	0.3056	0.6482
EB	0.0625	0.4274	3	0.3333	0.4635	0.0665	0.3056	0.2178
ED	_	+	6		_		0.3056	
Selection (	0.0625 of fourth	0.1436 Citv	0	0.1667	0.2853	0.0410	0.3030	0.1340
AB	0.0625	0.1436	3	0.3333	0.4635	0.0665	0.3673	0.1812
*AD	0.3594	0.4885	2	0.5000	0.6156	0.3007	0.3673	0.8187
Selection o	of lact City	,						
*DB	0.3594	0.4885	2	0.5000	0.6156	0.3007	0.3007	1.0000
Path for ar			E	0.5000 A	D	В	C 0.5007	1.0000
Distance			4	3	2	2	-	Total = 16
Ant 4 Path			4	<u> </u>				10tai - 10
Selection o		Citv						
*DA	0.1797	0.3007	2	0.5000	0.6156	0.1851	0.4522	0.4094
DB	0.1797	0.3007	2	0.5000	0.6156	0.1851	0.4522	0.4094
DC	0.0625	0.1436	6	0.1667	0.2853	0.0410	0.4522	0.0906
DE	0.0625	0.1436	6	0.1667	0.2853	0.0410	0.4522	0.0906
Selection o								
AB	0.0625	0.1436	3	0.3333	0.4635	0.0665	0.2793	0.2383
AC	0.0625	0.1436	6	0.1667	0.2853	0.0410	0.2793	0.1467
*AE	0.2422	0.3706	3	0.3333	0.4635	0.1718	0.2793	0.6150
Selection of				0.0000	011000	0.17.10	0.2755	0.0200
*EC	0.1250	0.2333	5	0.2000	0.3241	0.0756	0.1422	0.5319
EB	0.0625	0.1436	3	0.3333	0.4635	0.0665	0.1422	0.4680
Selection o				0.0000	011000	0.0000	012.122	011000
*CB	0.2969	0.4274	4	0.2500	0.3789	0.1619	0.1619	1.0000
Path for an		D	A	E	C	В	D	2.0000
Distance		-	2	3	4	5	2	Total = 16
Ant 5 Path								
Selection o		Citv						
*EA	0.2422	0.3706	3	0.3333	0.4635	0.1718	0.3677	0.4672
EB	0.0625	0.1436	3	0.3333	0.4635	0.0665	0.3677	0.1810
EC	0.1250	0.2333	4	0.2500	0.3789	0.0884	0.3677	0.2404
ED	0.0625	0.1436	6	0.1667	0.2853	0.0410	0.3677	0.1114
Selection o			· · ·	-		-		
AB	0.0625	0.1436	3	0.3333	0.4635	0.0665	0.2926	0.2274
AC	0.0625				0.2853		0.2926	0.1400
*AD	0.1797	_	2	0.5000	0.6156	0.1851	0.2926	0.6327
Selection o					-	-		
*DB	0.1797	0.3007	2	0.5000	0.6156	0.1851	0.2261	0.8188
	0.0625	0.1436	6	0.1667	0.2853	0.0410	0.2261	0.1812
Selection o		•	-					
*BC	0.2969	0.4274	5	0.2000	0.3241	0.1385	0.1385	1.0000
Path for ar	nt 5:	E	Α	D	В	С	E	
activition at	. J.	-	^	,	U	·	•	
			•	_	•	-		T-4-1 4C
Distance			3	2	2	5	4	Total = 16

Table 8: Iteration-5.

#### Conclusion

It is shown in the iteration number 5 that all the ants converge to the best path which gives minimum distance. The pheromone distribution for iteration and the next city selection based on maximum probability is determined in the iteration. It is evident from the analysis that the rich pheromone edge is converges the best path for the travelling salesmen problems.

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