Solving Traveling Salesman Problem using Ant Colony Optimization

Note - All the plots are generated, shown and saved at the for each test case for easy checking and visualization.

alpha (α), represents the pheromone's attractiveness to the ant, and
Beta (β) represents the exploration capability of the ant.
The probabilities for the next move of the ant is calculated using the below formula.

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

Pheromone (in table) is updated using the below formula.

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

Where

$$\Delta\tau_{ij}(t) = \sum_{k=1}^{m} \Delta\tau_{ij}^{\ k}(t)$$

$$\Delta\tau_{i,j}^{k} = \begin{cases} \dfrac{Q}{L_k} & if\,(i,j) \in \text{tour}_k \\ 0 & \text{otherwise} \end{cases}$$

Tour Length:

Assumption -

- The no of ants are taken to be the same as the number of cities (can be changed in the code though)

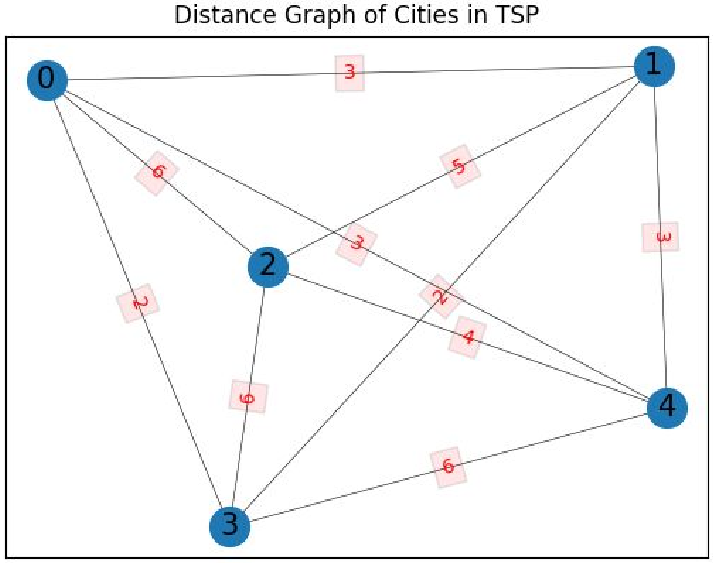
- After every iteration the ants start their journey from the same starting point as assigned in the beginning(randomly) (implemented in aco.solve(), alternate more random version is implemented in aco.solve2())
- Initial value of pheromone is 1 for all the connected cities
- The pheromone intensity Q (constant) is taken to be 1

Results - 1) For small value of n

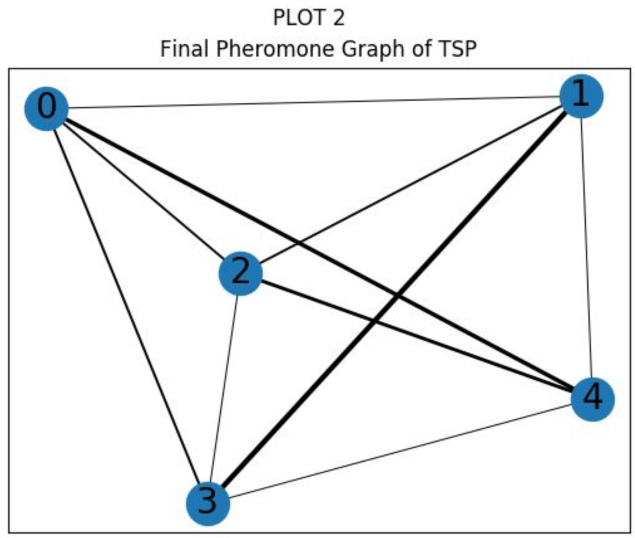
Distance Matrix ,dij, of the cities (example taken from an online source, link provided at last)

	A (0)	B (1)	C (2)	D (3)	E (4)
A (0)	0	3	6	2	3
B (1)	3	0	5	2	3
C (2)	6	5	0	6	4
D (3)	2	2	6	0	6
E (4)	3	3	4	6	0

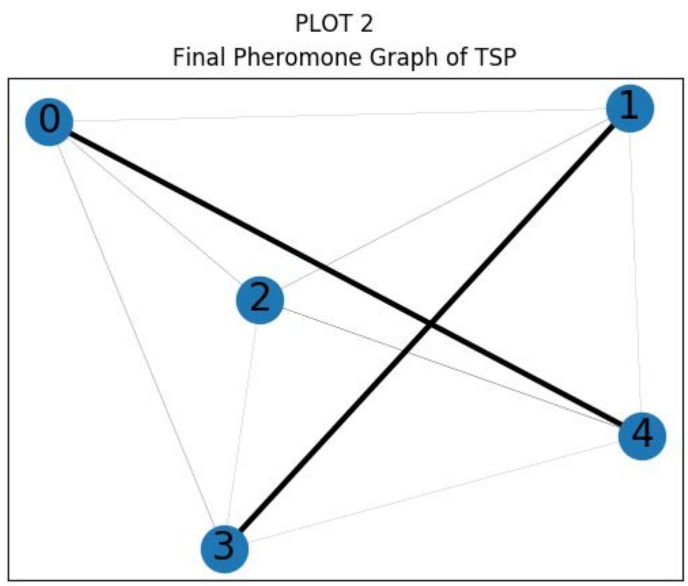
PLOT 1
Distance Graph of Cities in TSP



- alpha=0.7 ,beta= 0.7, rho=0.5, noofiterations= 5

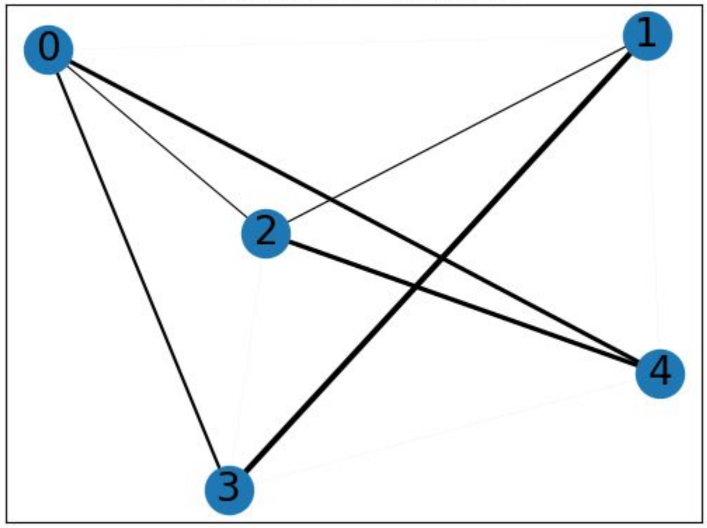


- alpha=1, beta=0, rho=0.5, noofiterations= 5



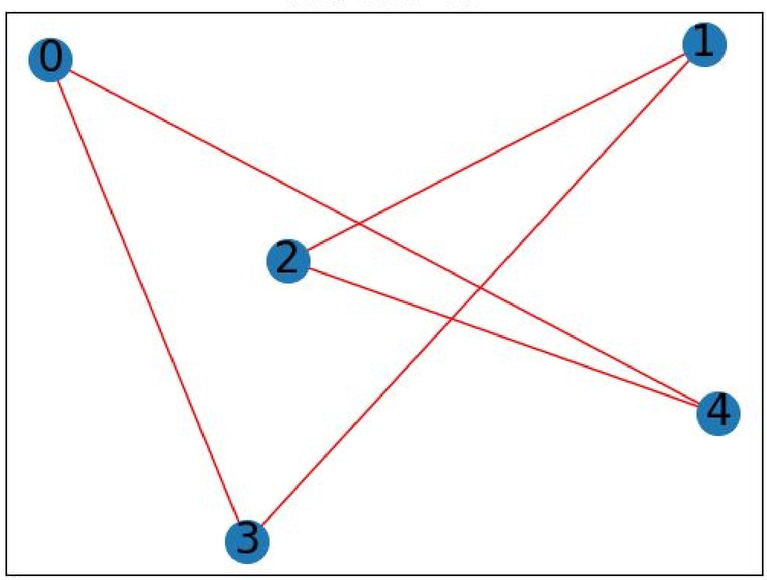
- apha=0, beta=1, rho=0.5, noofiterations= 5

PLOT 2
Final Pheromone Graph of TSP



In all the three cases the path chosen was the below with the t**otal cost 16.** The pheromone graph was different in the above cases in terms of amount of pheromone deposited (represented by thickness of edges).
The change in value of rho(=0), brings a cost of 17 in the second case as it completely dicards the old value and stores the new value only.

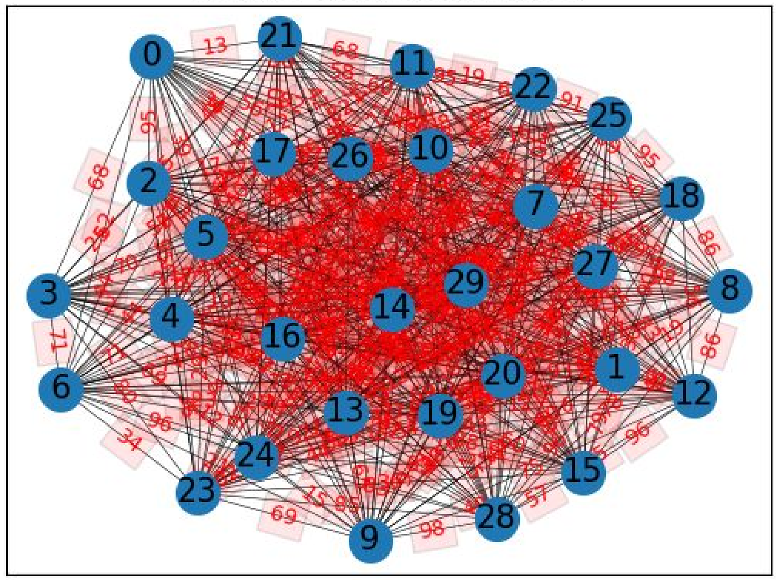
PLOT 3
Final Path Choosen in TSP
Total Cost = 16



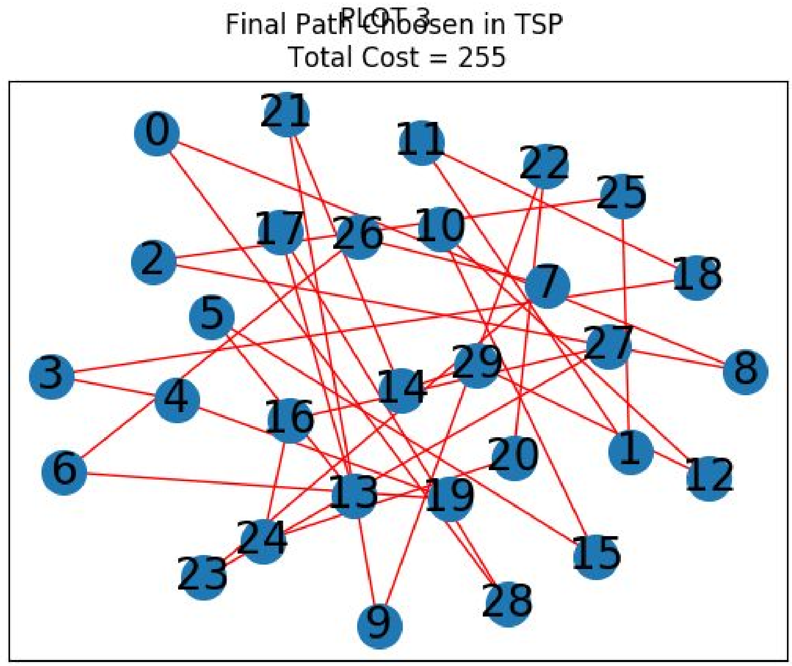
For large values of n (say 30), iterations=40 , distance in range of (1,100)

PLOT 1

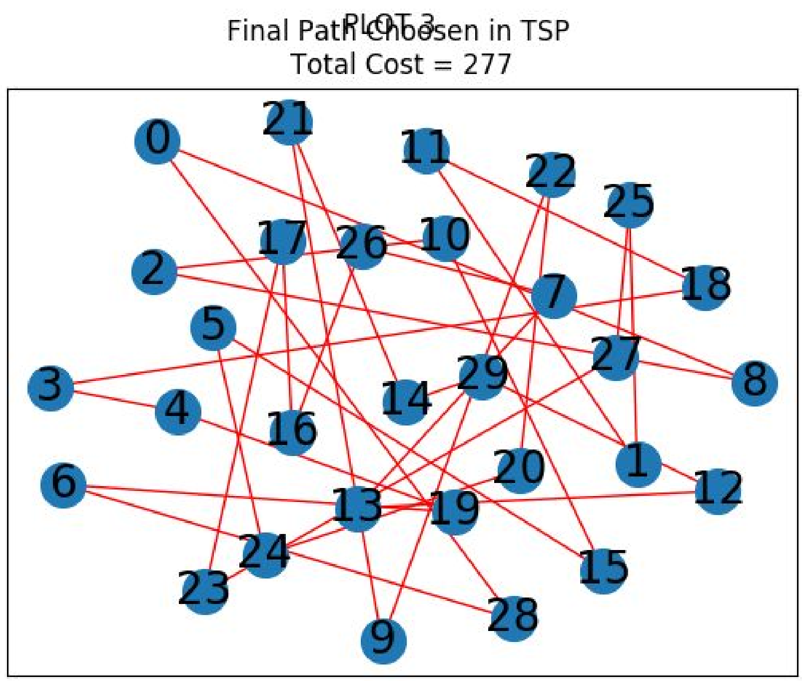
Distance Graph of Cities in TSP



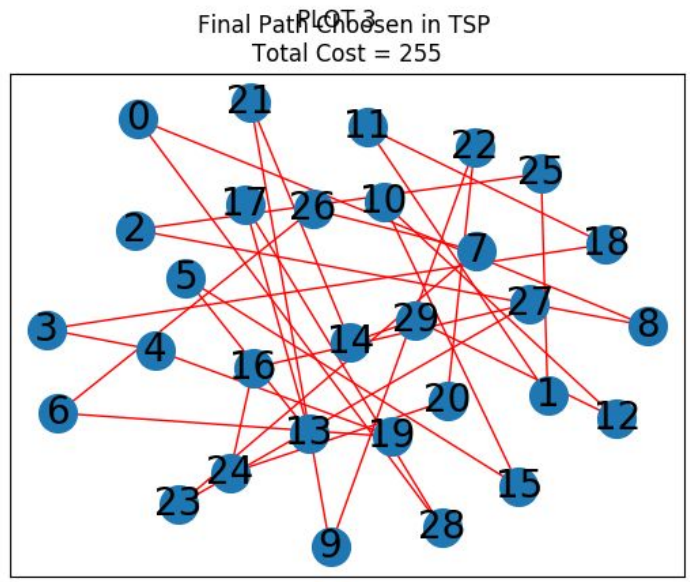
- alpha=0.7 ,beta= 0.7, rho=0.5



- alpha=1 ,beta= 0, rho=0.5



- alpha=0 ,beta= 1, rho=0.5



The total cost value differs in the above graphs. This difference increases with decrease in the no of iterations and vice versa.

For larger value of n, the difference in total cost becomes even more.