Assignment 4

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1 Introduction

The Travelling Salesman Problem:
Given a set of cities (coordinates) and distances between them, find the best (shortest) tour (visiting all cities exactly once and returning to the origin city) in a given amount of time,

2 Ant Colony Optimization

For this problem Ant colony optimization is implemented. This is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. Ants build a solutuion to TSP by moving on the problem graph from one city to another until they complete a tour. During an iteration of the AS algorithm each ant builds a tour executing one step for each node (city).
At the end of a tour, each ant lays pheromones on each edge it has used.The amount of pheromone is proportional to the performance of the ant.

$$p_{xy}^k = \frac{(\tau_{xy}^\alpha)(\eta_{xy}^\beta)}{\sum_{z \in \text{allowed}_x} (\tau_{xz}^\alpha)(\eta_{xz}^\beta)}$$

p^k : Probability of moving from state x to state y.
τ : Amount of pheromone deposited
$\eta_{xy} = 1/d_{xy}$ where d_{xy} is distance
Pheromone updating rule:

$$\tau_{xy} \leftarrow (1-\rho)\tau_{xy} + \sum_k^m \Delta\tau_{xy}^k$$

$\Delta\tau_{xy}^{k}$: Amount of pheromone deposited by kth ant.

$$\Delta\tau_{xy}^{k} = \begin{cases} Q/L_k & \text{if ant } k \text{ uses curve } xy \text{ in its tour} \\ 0 & \text{otherwise} \end{cases}$$

L_k is cot of kth ant tour and Q is constant.
Probability depends on parameters α and β. Q is a constant used for updating the pheromone. ρ plays major role in updating the pheromone as it is the evaporation constant.
Optimal path length is obtained by determining some values for above four parameters.

3 Pseudocode

Begin
Initialize
while stopping criterion not satisfied ***do***
Position each ant in a starting node
Repeat
For each ant ***do***
Choose next node by applying state transition rule
Apply step by step pheromone update
End for
Until every ant has built a solution
Update best solution
Apply offline Pheromone update
End while
End

4 Output

The best solution obtained using this algorithm for Travelling Salesman Problem for euclidean is 1590 and for noneuclidean it is 5246.