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Proposed Optimal Solution of TSP Using ACO

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ABSTRACT
The TSP is a very important problem in the context of Ant Colony Optimization because it is the problem to which the original AS was first applied, and it has later often been used as a benchmark to test a new idea and algorithmic variants. It is a metaphor problem for the ant colony It is one of the most studied NP-hard problems in the combinatorial optimization it is very easily to explain. So that the algorithm behavior is not obscured by too many technicalities. In this paper it is discussed how ACO can be used for solving Travelling salesman problem.
Keywords:- TSP,ACO,Pheromone,Etc.

I. INTRODUCTION

Traveling salesman problem was defined by IRISH mathematician W.R. Hamilton & British mathematician Thomas Kirkman.It is about a salesman traveling between N cities. Starting and End point is same & during the visits each city is visited only once.Each city is connected to other/close by cities by road air or railways. Each of links between the cities has one of more weights/cost attached. The cost describes the difficulty to transverse this edge on graph. Salesman wants to keep the cost as well as distance as low as possible.

II. COMBINATORIAL OPTIMIZATION

TSP is optimization combinatorial problem.

Π = (S, f, Ω) – problem instance

S – set of candidate solutions

f – objective function

Ω – set of constraints

*Find globally optimal feasible solution s**

Why TSP is difficult to solve Seems very easy to understand the problem Most easiest method is brute force ie. Try every possibilities If we have 60 cities then if wecan start any city and goforward/backward.possiblesolution=(601)!/2=?693,415,592,728,449,178,689,695,098,601,94,703,172,951,438,386,343,716,270,410647,470,080,000,000,000,000

III. SWARM INTELLIGENCE & ACO

Swarm intelligence is a relatively new approach to problem solving that takes inspiration from the social behaviours of insects and of other animals. The attempt in the research of computer technology is to develop algorithms inspired by insect behaviour to solve optimization problems. Ant colony optimization (ACO) is one of the most successful techniques in the wider field of swarm intelligence. Many research works have been devoted to ant colony optimization techniques in different areas. It is a relatively novel meta-heuristic technique and has been successfully used in many applications especially problems that belong to the combinatorial optimization. ACO inspired by the foraging behaviour of real ant was first introduced by Dorrigo and his colleagues ([1], [2]) in early 1990s and has become one of the most efficient algorithms for TSP. ACO is based on the pheromone trail laying and following behaviour of some ant species, a behaviour that was shown to allow real ant colonies to find shortest paths between their colony and food sources. These ants deposit pheromone on the ground in order to mark some favourable path that should be followed by other members of the colony

A. *Characteristics of a swarm:*

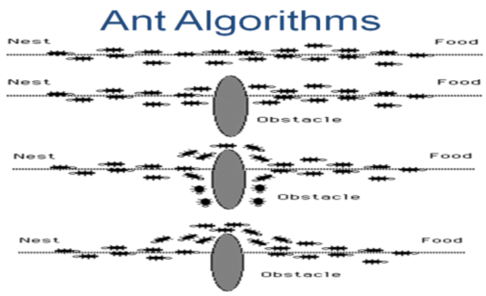
Distributed, no central control or data source;

Limited communication

No (explicit) model of the environment;

Perception of environment (sensing)

Ability to react to environment changest



B. Model of ACO System

- Virtual "trail" accumulated on path segment Starting node selected at random Path selected @ Probabilistic mechanism based on amount of "trail" present on possible paths from starting node higher probability for paths with more "trail" Ant reaches next node, selects next path Continues until reaches starting node Finished "tour" is a solution. A completed tour is analysed for optimality"Trail" amount adjusted to favor better solutions
  - better solutions receive more trail
  - worse solutions receive less trail
  - higher probability of ant selecting path that is part of a better-performing tour New cycle is performed
- Repeated until most ants select the same tour on every cycle (convergence to solution)

C ACO system as proposed solution to TSP

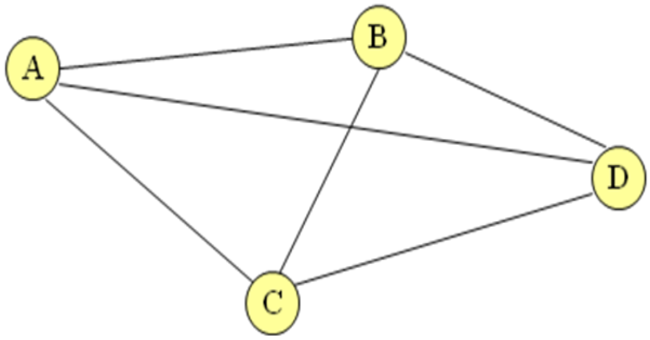
- TSP (Travelling Salesman Problem): shortest path between n nodes
- Algorithm in Pseudocode:
  - **Initialize** Trail
  - **Do While** (Stopping Criteria Not Satisfied) – Cycle Loop
    - **Do Until** (Each Ant Completes a Tour) – Tour Loop
    - Local Trail Update
    - **End Do**
    - Analyze Tours
    - Global Trail Update
  - **End Do**

IV. PROPOSED IMPLEMENTATION

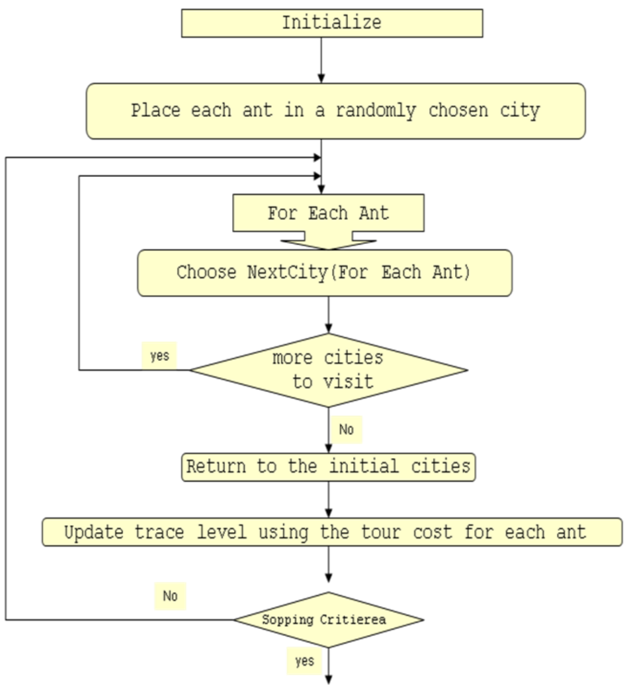
- Ants: Assumed Simple computer agents
- Move ant:Pick next component in the construction of solution
- Trace: Λij Pheromone, a global type of information
- Memory:M_K

Next move:Use probability to move ant

Graph (N,E): where N = cities(nodes), E = edges = *the tour cost from city i to city j (edge weight)* Ant move from one city i to the next j with some transition probability.

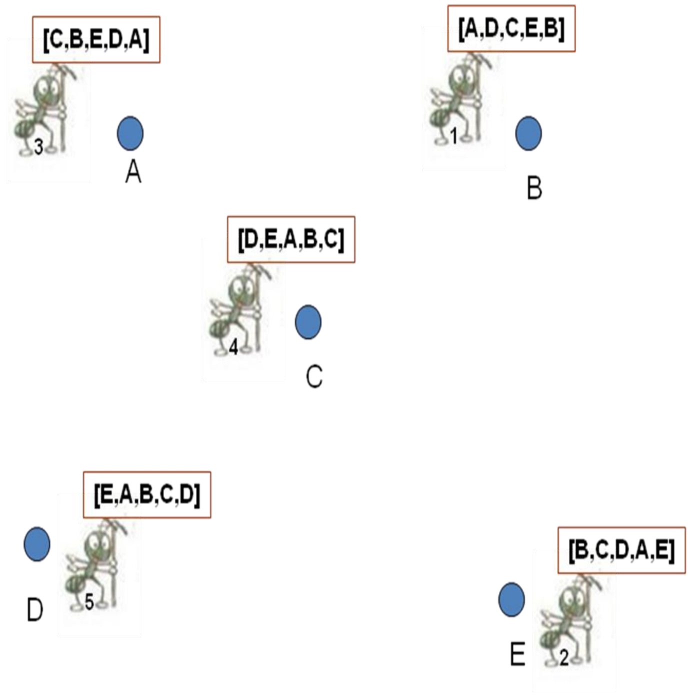


Each edge is associated a *static value* based on the edge-cost $\eta(r,s) = 1/d_{r,s}$.Each edge of the graph is augmented with a trace pheromone $\tau(r,s)$ deposited by ants. Initially, 0. *Trace is dynamic and* it is learned at run-time Each ant tries to produce a complete tour, using the probability depending on $\eta(r,s)$ and $\tau(r,s)$ to choose the next city depending of formula given the table below.



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

Figure below shows how different cities can be selected depending on the probability of choosing the next city. In the figure we have taken five ant agents which are randomly placed on the different cities which are named A B C D & E ,Now in the next iteration each ant select the next city to visit & next city is selected on basis of probability given the formula above after five number continuous iteration the trail of ants is shown in figure above that how it reached to last node and what were the intermediate nodes visited. All the nodes which are visited in mid are placed in visited matrix.Mk



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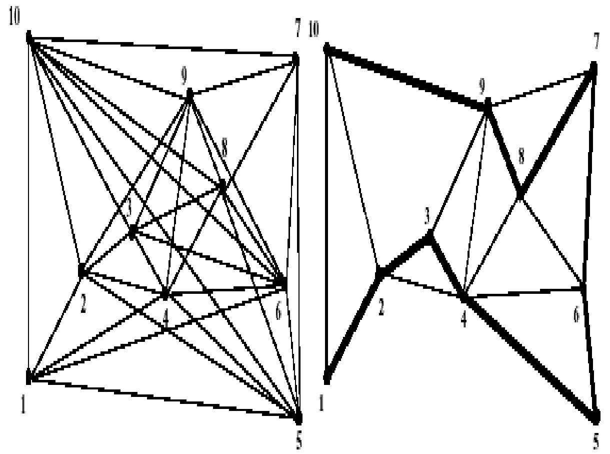
A STOPPING CRITERION

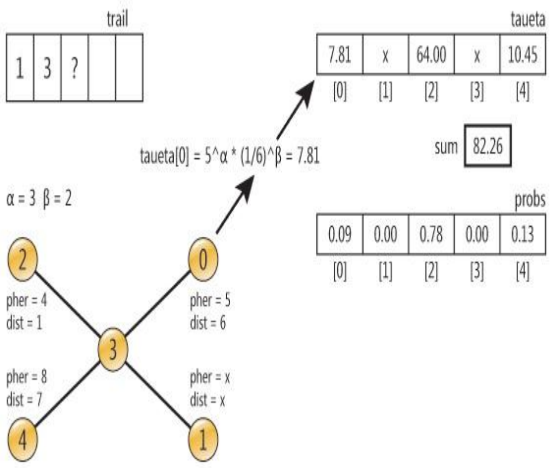
- Stagnation
- Max Iteration

Iteration are stopped when we see that no new paths is being selected after a fix number of iterations. This path which is stored in visited matrix M will give solution of TSP problem which is optimal given by ant colony optimization.

Every time the intensity of pheromone is measured & Only that path is selected which has best intensity and others paths are ignored.



B PHEROMONE CALCULATION SAMPLE



V. CONCLUSION

Research has been done & many solution has emerged for TSP but further research is required which solution is optimal in this direction the proposed solution given in this paper is best solution as compared to Greedy algorithm specially when the number cities are very large (>500) ACO tries every possible solutions in very short time & optimal solution is emerges itself after stagnation.

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