Ant Colony Optimization

ON KP

Queen → Eggs → larva → pupa $\xrightarrow{\text{transformation}}$ Adult Ant

Eggs

```
if(Egg= fertilized)
{
  child= female;
}
else {
  child= male;
}
```

larva

① immobile
② feb and cared by workers
③ food → liquid

Adult Ant

① mobile
② food → solid
③ seeds
④ ~~pices~~ pieces of prey

Ants Colony → Queen, Male/Drone, female workers, Soldier Ants

Queen

① only ant in the colony that can lay eggs

Male/Drone

female workers

Soldier Ants

① protect the Queen and Colonies
② Attack enemy colony
③ Collect heavy foods

Pheromones → ① Ant's easily communicate with each other using pheromones

② chemical signal and used by ants for communication in the environment

③ ant's release pheromones in danger (to ~~alter~~ alert other ants)

④ detect pheromones through their antennas.

⑤ ants leaves pheromones on the soil. that can detect | followed by another ants.

- ACO is inspired by social behaviour of real ants.
- ACO is basically inspired by pheromones based Ant communication
- the technique is used to find optimal paths.
- ACO is used for routing and load Balancing problem. eg- TSP
- ACO can be applied to continuous optimization problem

ACO Algorithm

1. initialize ACO parameters
2. Ant Solution construction
3. Position Each ant in the starting node.
4. Each ant will select next node by applying ~~5 Repeat untill ant Build~~ state transition rule.
5. Repeat untill ant Build the best solution, then compute the fitness value.
6. update the best solution.
7. apply offline pheromone update
8. Display the best result.

① Initialize ACO parameters :-

Population Size (K) = 20; [% total no. of artificial ant or agents]

MaxT = 200; [% maximum no. of iterations]

tau = 0.5; [% Pheromones initial value]

Alpha = 1; [% pheromones Exponential weight]

Beta = 1; [% Pheromone ~~to~~ heuristic weight]

rho = 0.005; [% pheromone evaporation rate]

② ACO ~~Ant~~ solution Construction :-

1st Start with main loop

Current Iteration = 1 to maximum number of iteration

Current Iterations = 1 to MaxT

Current Iterations = 200

③ Position Each ant in the Starting node

K → no. of ant.

P_{ij} → ant move from node i to node j.

K th ant move from node i to node j with probability [transition probability]

$$P^{k}_{ij} = \frac{(\tau^{\alpha}_{ij})(\eta^{\beta}_{ij})}{\sum_{z \in allowed_i} (\tau^{\alpha}_{ij})(\eta^{\beta}_{ij})}$$

↑
probability

[η → rho]

(1) $P_{ij}^{k} \rightarrow$ ant
$\rightarrow$ probability of moving from node i to node j.

(2) $\tau_{ij}^{\alpha} \rightarrow$ total pheromone deposit by ant on path ij

(3) $\eta_{ij}^{\beta} \rightarrow$ value of path ij

(4) $\boxed{n=4}$ (population size). (K $\rightarrow$ population size)

(5) Repeat until ant build the best solution, then compute the fitness value.

(6) Update the best solution.

Compare the Best solution with each ant solution

If (Ant (3) solution < Best solution)
{
Consider Ant (3) Best solution
}

Ant (K $\rightarrow$ population size).

$K = 1, 2, 3, 4, 5 \ldots 20.$

(7) Apply offline pheromone update.

(8) pheromone trials are updated when all ants completed the cost / solution.

① for [Best] solution ⇒ increase level of pheromones highly.

② for [worst] solution ⇒ decrease level of pheromones

Pheromone updating equation :-

$$\tau_{ij} \leftarrow (1-\rho)\,\tau_{ij} + \sum_{k}^{m} \Delta\tau_{ij}^{k}$$

m → No. of ants

τ_{ij} → total pheromones deposit by ant on path ij.

$(1-\rho)$ → pheromone evaporation

$\Delta\tau_{ij}^{k}$ → total pheromones deposit by kth ant on path ij

$$\tau_{ij} \leftarrow (1-\rho)\,\tau_{ij} + \sum_{k}^{m} \Delta\tau_{ij}^{k}$$

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

$\Delta\tau_{ij}^{k} = \dfrac{Q}{L_k}$

Q → 1 (constant)

L → path length

Constant (Q = 1) used in $\Delta\tau_{ij}^{k}$.

⑧ Display the Best Solution

loop will repeat untill maximum no. of iterations (eg → 200) after that it will display best solution. (optimal solution).