Date: 20.08.25

TASK:5

Implementation of Ant Colony Optimization to find the shortest and most efficient route for ride-sharing/delivery services using Python

Implementation of Ant Colony Optimization to Optimize Ride-Sharing Trip Duration using Python by following constraints.

- •To forecast travel times between every pair of pick-up and drop-off locations.
- •To find the shortest route that visits a set of locations.
- •To implement optimization techniques are required to intelligently search the solution space and find near-optimal solutions.

Tools: Python

PROBLEM STATEMENT:

CO₂

S3

A logistics company is trying to improve the efficiency of its delivery trucks by minimizing the total travel distance required to visit multiple customer locations. Each truck must start from the depot, deliver to every customer exactly once, and return to the depot. The road network is represented as a distance matrix between all customer locations. Since finding the shortest possible route is a complex combinatorial optimization problem, the company decides to use the Ant Colony Optimization (ACO) algorithm. The algorithm simulates the behavior of ants searching for food, where ants explore different routes and deposit pheromones on shorter paths. Over time, the pheromone trails guide future ants to choose better routes, leading to the discovery of a near-optimal delivery path that reduces fuel consumption, delivery time, and overall operational cost.

ANT COLONY OPTIMIZATION

AIM

To implementation of Ant Colony Optimization to find the shortest and most efficient route for ride-sharing or delivery services using Python

ALGORITHM

- 1. Initialize pheromone levels on all routes.
- 2. Place ants at the starting city
- 3. For each ant:

Build a path by moving to the next city based on:

Pheromone strength (experience).

Visibility (shorter distance is preferred).

- 4. Calculate the total distance (cost) of each ant's path.
- 5. Update pheromones:

Evaporate some pheromone on all paths.

Add pheromone to the paths used by ants (better paths get more).

- 6.Repeat steps 3–5 for a number of iterations.
- 7. Return the best path and its cost found during the process.

PROGRAM

Delivery optimization using Ant Colony Optimization

```
iteration = 100 # number of iterations
                # number of ants
n ants = 5
                # number of cities
n \text{ citys} = 5
# Parameters
e = 0.5 # evaporation rate
alpha = 1 # pheromone influence
beta = 2 # visibility influence
# Visibility = 1/distance
visibility = 1 / d
visibility[visibility == inf] = 0
# Initial pheromone levels
pheromone = 0.1 * np.ones((n citys, n citys))
# Routes for ants
routes = np.ones((n ants, n citys + 1))
for ite in range(iteration):
  routes[:, 0] = 1 # all ants start at city 1
  for i in range(n ants):
     temp visibility = np.array(visibility)
     for j in range(n_citys - 1):
       cur loc = int(routes[i, j] - 1)
       temp_visibility[:, cur_loc] = 0
       # pheromone and visibility contributions
       pheromone_feat = np.power(pheromone[cur_loc, :], alpha)
       vis feat = np.power(temp visibility[cur loc, :], beta)
       prob = pheromone feat * vis feat
```

[14, 8, 14, 16, 0]]

```
prob = prob / prob.sum() # normalize
       cum prob = np.cumsum(prob)
       r = np.random.random()
       city = np.nonzero(cum prob > r)[0][0] + 1
       routes[i, j + 1] = city
     # last city not visited
     left = list(set([i for i in range(1, n\_citys + 1)]) - set(routes[i, :-2]))[0]
     routes[i, -2] = left
  route opt = np.array(routes)
  dist_cost = np.zeros((n_ants, 1))
  for i in range(n ants):
     s = 0
     for j in range(n citys - 1):
       s += d[int(route\_opt[i, j]) - 1, int(route\_opt[i, j + 1]) - 1]
     dist cost[i] = s
  dist min loc = np.argmin(dist cost)
  dist min cost = dist cost[dist min loc]
  best route = routes[dist min loc, :]
  pheromone = (1 - e) * pheromone
  for i in range(n ants):
     for j in range(n_citys - 1):
       dt = 1 / dist cost[i]
       pheromone[int(route opt[i, j]) - 1, int(route opt[i, j + 1]) - 1] += dt
print("Routes of all ants at the end:")
print(route_opt)
print("\nBest Path:", best route)
print("Cost of the Best Path:", int(dist min cost[0]) + d[int(best route[-2]) - 1, 0])
```

OUTPUT

=====

Routes of all ants at the end:

[[1. 2. 5. 3. 4. 1.]

[1. 2. 5. 3. 4. 1.]

[1. 2. 5. 3. 4. 1.]

[1. 2. 5. 3. 4. 1.]

[1. 2. 5. 3. 4. 1.]]

Best Path: [1. 2. 5. 3. 4. 1.]

Cost of the Best Path: 52

RESULT

Thus, the implementation of Ant Colony Optimization to find the shortest and most efficient route for ride-sharing or delivery services using Python was successfully executed and output was verified