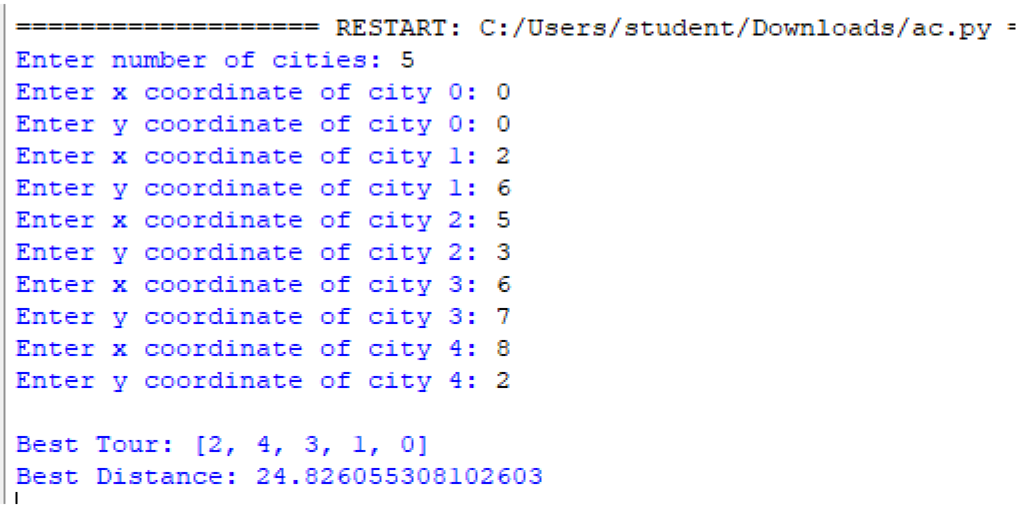
ACO

```
import random
import math
# -----------------------------
# Distance between two cities
# -----------------------------
def distance(c1, c2):
    return math.sqrt((c1[0] - c2[0])**2 + (c1[1] - c2[1])**2)
# -----------------------------
# Total distance of a tour
# -----------------------------
def total_distance(tour, cities):
    dist = 0
    for i in range(len(tour)):
        dist += distance(cities[tour[i]],
                        cities[tour[(i + 1) % len(tour)]])
    return dist
# -----------------------------
# Ant Colony Optimization
# -----------------------------
def ant_colony_tsp(cities, ants, iterations, alpha, beta, evaporation):
    n = len(cities)
    pheromone = [[1.0]*n for _ in range(n)]
    best_tour = None
    best_len = float('inf')
    for _ in range(iterations):
        tours = []
```

```
for _ in range(ants):
    unvisited = list(range(n))
    start = random.choice(unvisited)
    tour = [start]
    unvisited.remove(start)

    while unvisited:
        cur = tour[-1]
        probs = []

        for city in unvisited:
            tau = pheromone[cur][city] ** alpha
            eta = (1 / distance(cities[cur], cities[city])) ** beta
            probs.append(tau * eta)

        next_city = random.choices(unvisited, probs)[0]
        tour.append(next_city)
        unvisited.remove(next_city)

    length = total_distance(tour, cities)
    tours.append((tour, length))

    if length < best_len:
        best_len = length
        best_tour = tour

# Evaporation
for i in range(n):
    for j in range(n):
```

```
                pheromone[i][j] *= (1 - evaporation)

        # Update pheromones
        for tour, length in tours:
            for i in range(n):
                a = tour[i]
                b = tour[(i + 1) % n]
                pheromone[a][b] += 1 / length
                pheromone[b][a] += 1 / length

    return best_tour, best_len
# -----------------------------
# INPUT SECTION (No hardcoding)
# -----------------------------
cities = []
n = int(input("Enter number of cities: "))

for i in range(n):
    x = float(input(f"Enter x coordinate of city {i}: "))
    y = float(input(f"Enter y coordinate of city {i}: "))
    cities.append((x, y))

best_tour, best_distance = ant_colony_tsp(
    cities,
    ants=10,
    iterations=100,
    alpha=1,
    beta=5,
    evaporation=0.5
)

print("\nBest Tour:", best_tour)

print("Best Distance:", best_distance)
```



```
=================== RESTART: C:/Users/student/Downloads/ac.py =
Enter number of cities: 5
Enter x coordinate of city 0: 0
Enter y coordinate of city 0: 0
Enter x coordinate of city 1: 2
Enter y coordinate of city 1: 6
Enter x coordinate of city 2: 5
Enter y coordinate of city 2: 3
Enter x coordinate of city 3: 6
Enter y coordinate of city 3: 7
Enter x coordinate of city 4: 8
Enter y coordinate of city 4: 2

Best Tour: [2, 4, 3, 1, 0]
Best Distance: 24.826055308102603
```