



Arab Academy for Science, Technology and Maritime Transport

College of Artificial Intelligence

Course	Swarm Intelligence (RB414)	Feb. 2025
Teaching Staff	Dr. Omar Shalash	Eng. Ahmed Métwalli

Sheet 1: Ant Colony Optimization

Coordinates of Points (cities):

$$\begin{aligned}x_1 &= (9, 76), \\x_2 &= (28, 75), \\x_3 &= (98, 3), \\x_4 &= (69, 27).\end{aligned}$$

ACO Parameters:

Population Size = 4,
Maximum Iterations = 10,
Pheromone Evaporation Rate = 0.05,
Artificial Pheromone (Initial) = 0.0453,
 $\alpha = 1$, $\beta = 1$, $Q = 1$.

We need to find the shortest route visiting each of the four points $\{x_1, x_2, x_3, x_4\}$ exactly once and returning to the start, using the Ant Colony Optimization steps:

1. Initialize pheromone values on all edges to the *artificial pheromone* (0.0453).
2. Place 4 ants on different starting nodes.
3. Compute paths based on probability (influenced by pheromone τ_{ij} and distance via $\eta_{ij} = 1/d_{ij}$).
4. Update pheromone intensities on edges used by ants.
5. Repeat until the maximum iteration (10) or convergence.

Table 1: Distance Matrix d_{ij}

$i \setminus j$	1	2	3	4
1	–	19.03	115.22	77.47
2	19.03	–	100.42	63.17
3	115.22	100.42	–	37.65
4	77.47	63.17	37.65	–

(Values are rounded to 2 decimal places.)

Objective: Use these matrices and the above ACO parameters to find the **shortest tour** that visits each point $(x_1 \rightarrow x_2 \rightarrow x_3 \rightarrow x_4 \rightarrow x_1)$ only once.