Ant Colony Optimization

Peyman Shobeiri

Supervisor : Dr.Balochian

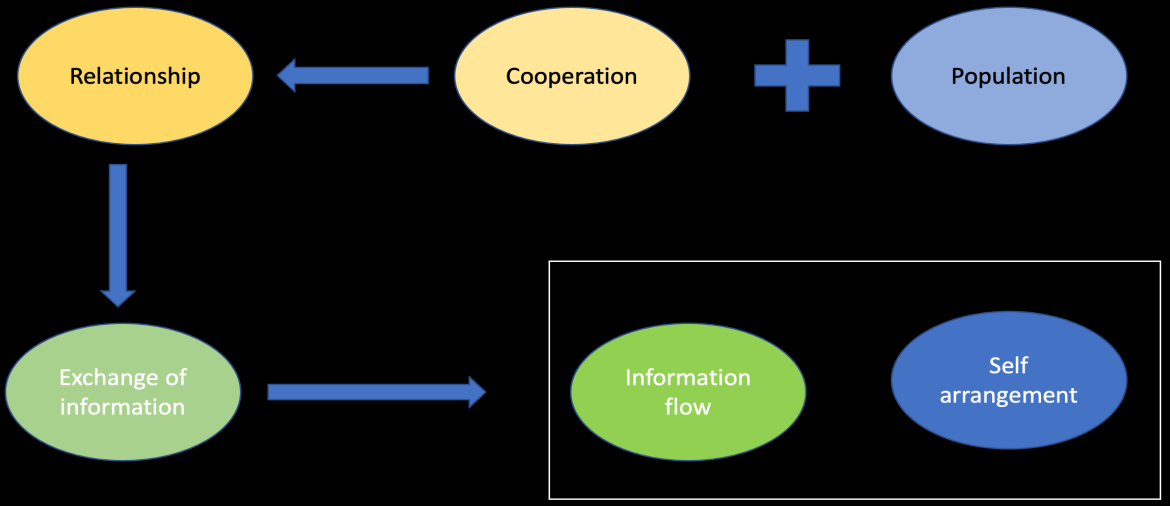
Principles of Robotics

Topics

- Introduction
- ACO
- Example
- Conclusion

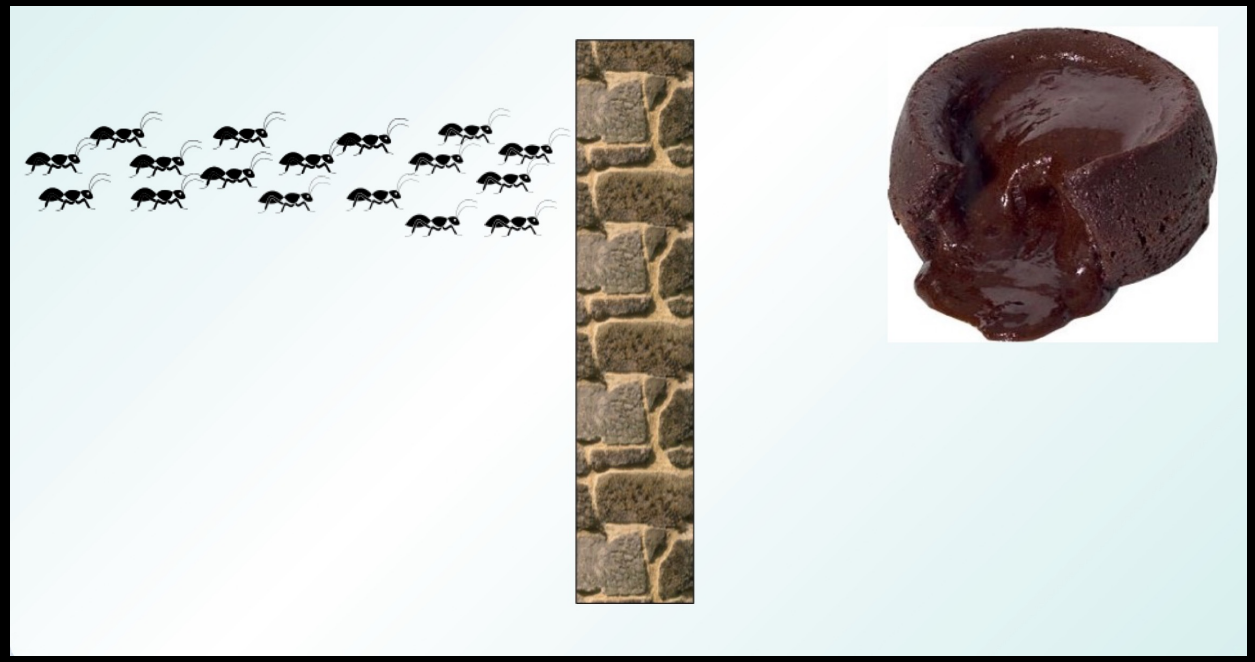
Swarm Intelligence

"Swarm intelligence (SI) is artificial intelligence based on the collective behavior of decentralized, self-organized systems"



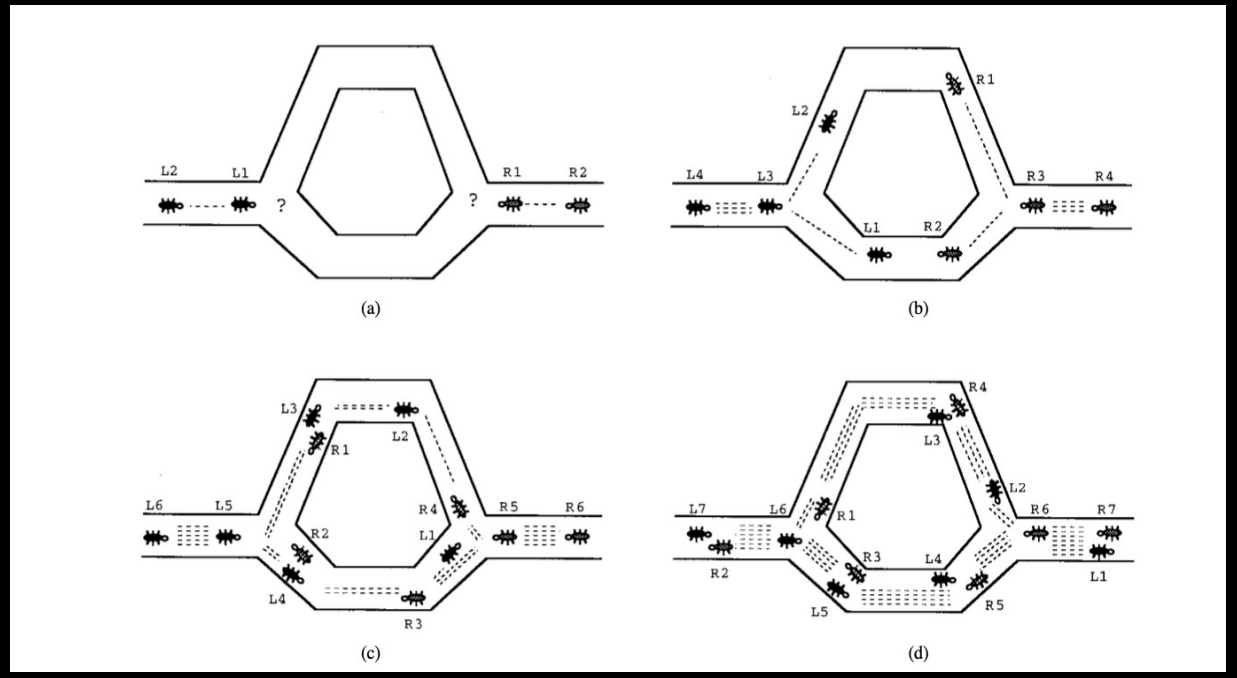
ACO

The Ant Colony optimization (ACO) meta-heuristic is a popular technique for solving computational optimization problems, which was firstly introduced by Dorigo in 1992. ACO is simulated by the behavior of real ant colonies finding the shortest path between their nest and a food source.

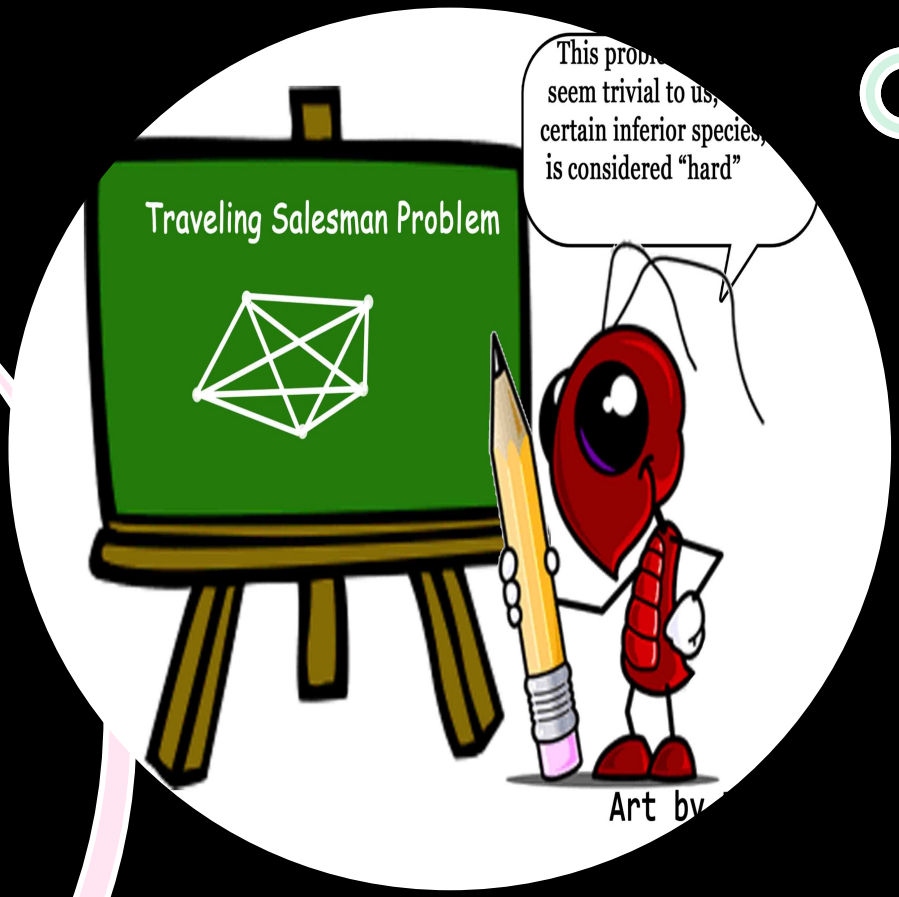


ACO

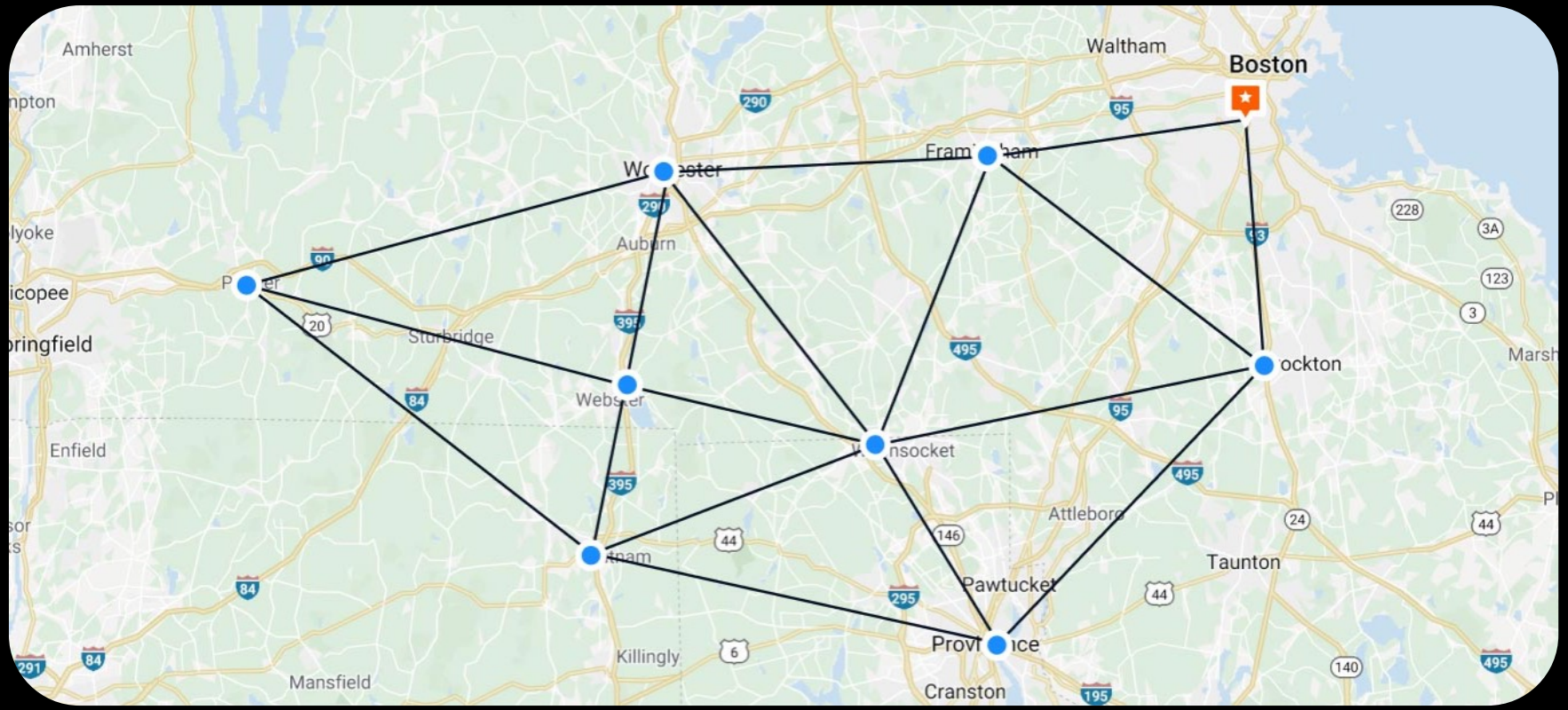
When a group of ants searches for a food source, they deposit pheromone on their way. Therefore, they can communicate with each other and follow the trails of the other ants to the food source. As more ants travel through the same path, the intensity of the pheromone increases, and as the pheromone evaporates, the intensity decreases. Through this process, the ants can identify the shortest path to the food source by following the path with the most pheromones.



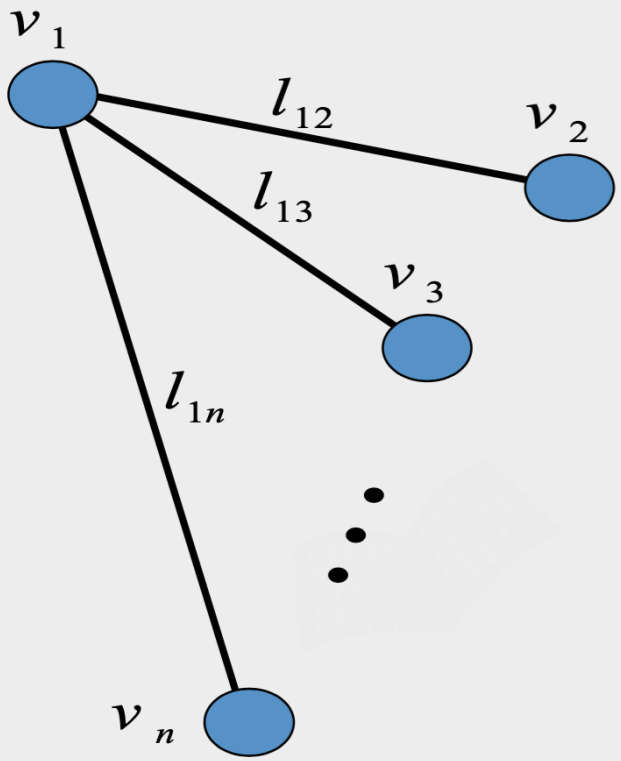
Example


Traveling Salesman Problem
seem trivial to us,
certain inferior species,
is considered “hard”
Art by

Traveling Salesman Problem



TSP



$$V = \{v_1, v_2, \ldots, v_n\}$$

$$L = \left\{ l_{ij} \,\middle|\, (v_i, v_j) \in W \subseteq V \times V \right\}$$

$$G = (V, L)$$

$$J : L \rightarrow \square^{\geq 0}$$

$$J(l_{ij}) = d_{ij}$$

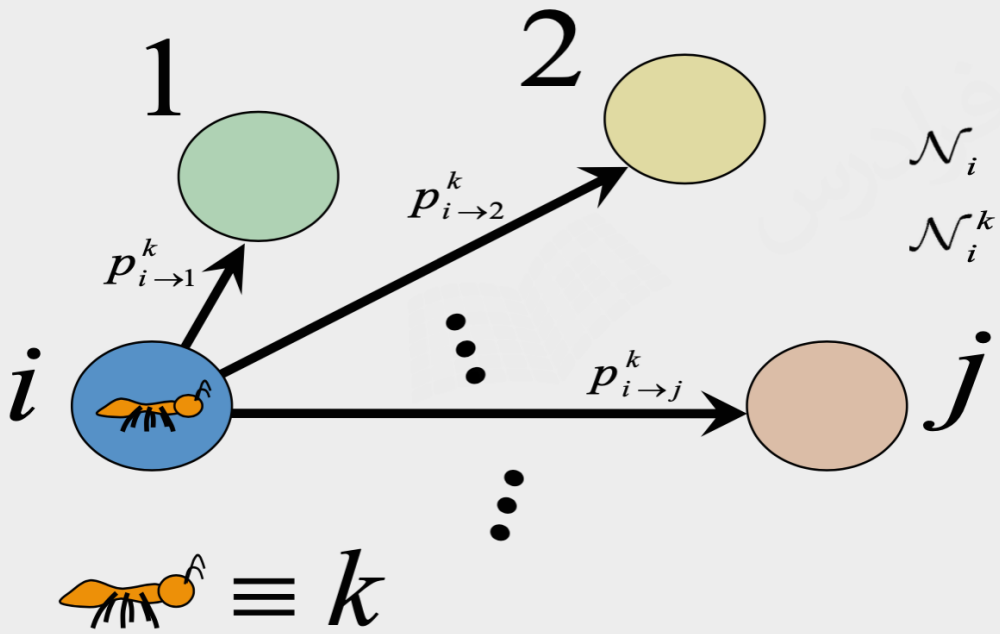
$$D = \left[d_{ij} \right]_{n \times n} \quad , d_{ii} = 0$$

$$\eta_{ij} = \frac{1}{d_{ij}}$$

$$p_{i\to j}^{k} = p_{ij}^{k} = \begin{cases} \dfrac{(\tau_{ij})^{\alpha}(\eta_{ij})^{\beta}}{\sum_{m\in\mathcal{N}_i^k}(\tau_{im})^{\alpha}(\eta_{im})^{\beta}} & , j \in \mathcal{N}_i^k \\ 0 & , j \notin \mathcal{N}_i^k \end{cases}$$

$$\mathcal{N}_i = \{m \,|\, l_{im} \in L\}$$

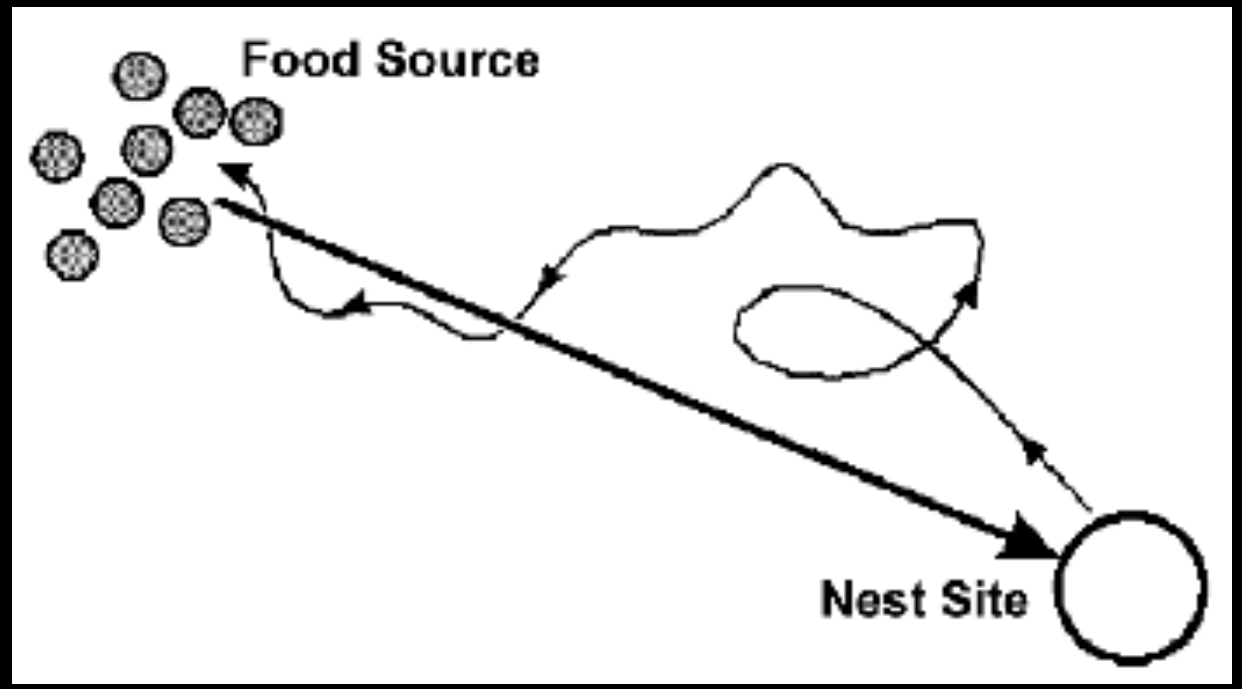
$$\mathcal{N}_i^k = \{m \,|\, m \in \mathcal{N}_i \wedge m \notin \Psi^k\} = \mathcal{N}_i - \Psi^k$$



TSP

whenever an ant builds a solution, the algorithm updates pheromone values according to the local updating rule, which is calculated as follows:

$$\tau_{c(j)} = (1 - \rho) \cdot \tau_{c(j)}$$



Conclusion

ACO is hugely beneficial for :

1. Vehicle routing
2. Traffic management
3. Resource allocation
4. Network routing
5. Optimization problems
6. Scheduling
7. …

THANK YOU

References

https://www.researchgate.net/publication/308953674_Ant_Colony_Optimization

https://github.com/PeymanShobeiri/Ant-Colony-optimization