Grokking Artificial intelligence Algorithms
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Section 6 Swarm Intelligence Ants

Swarm intelligence algorithms are a subset of evolutionary algorithms that were discussed in chapter 5 and are also known as nature-inspired algorithms. As with the theory of evolution, the observation of the behavior of life forms in nature are the inspiration for the concepts behind swarm intelligence. When we observe the world around us, we see many life forms that are seemingly primitive and unintelligent as individuals, yet exhibit intelligent emergent behavior when acting in groups

Applicable problems

One such problem is trying to visit every attraction at the fair and finding the shortest distance traveled. Very similar to the traveling salesman problem that was worked on for A2. Ants have 3 different properties about them, memory or list of attractions if we use the fair example, best fitness which represents the shortest path, and action which is dropping pheromones along their way to the next destination. For the ACO we will make sure to initialize the pheromone trail to all the locations to 1. Ants will start at random locations. Ants need to select their next attraction and visit new ones until they have visited all of them. When an ant faces the decision of choosing the next destination that is not random, it determines the pheromone intensity on that path and the heuristic value by using a formula(pictured below). Using alpha and beta superscripts the formula can give greater influence to either the heuristics value or the pheromone value. After visiting all available locations we can assign probabilities of attractions being visited. We can then use roulette wheel selection methods and this continues until every ant has visited every location. Once all are visited we have a pheromone trail left over that we have to update through deposition and evaporation since in the real world trails evaporate. Pheromones are updated by multiplying their respective current values by an evaporation factor—a parameter that can be adjusted to tweak the performance of the algorithm in terms of exploration and exploitation. We can determine which ant is the best in the colony by seeing their total distance traveled. The algorithm stops when a certain number of iterations occurs or when the best solution stagnates.

Important Figures

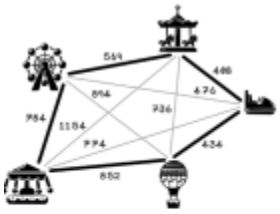
Formula for selecting destination

Selecting destination based on a heuristic

When an ant faces the decision of choosing the next destination that is not random, it determines the pheromone intensity on that path and the heuristic value by using the following formula:

$$\frac{(\text{pheromones on path x})^{a} * (1 / \text{heuristic for path x})^{b}}{\sum_{\text{n available destinations}} ((\text{pheromones on path n})^{a} * (1 / \text{heuristic for path n})^{b})}$$

Path and pheromones

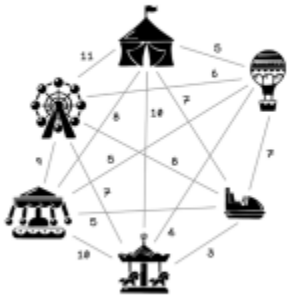


ACO is useful for optimization problems like finding shortest paths or optimal task schedules.

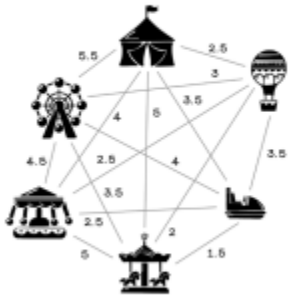
Ants have a concept of memory and performance, and can perform actions.

Pheromone evaporation visualized

Pheromones are contributed by each ant proportional to its respective performance. Pheromones also evaporate.



Pheromones on paths



Pheromones on paths after 50% evaporation