

Ant Colony Optimization Algorithm

Overview

This repository contains an implementation of the Ant Colony Optimization (ACO) algorithm in Python. The ACO algorithm is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. This implementation is tailored for solving the Traveling Salesman Problem (TSP).

Features

- Initialization of pheromones and distances
- Generation of paths based on pheromone and heuristic information
- Updating pheromones based on the quality of paths
- Adjustable parameters for the number of ants, number of best paths to consider, number of iterations, decay rate, and the influence of pheromone versus distance (alpha and beta)

Requirements

- Python 3.x
- NumPy

Usage

Here is an example of how to use the Ant Colony Optimization algorithm:

```
import numpy as np
from ant_colony import AntColony

distances = np.array([[np.inf, 2, 2, 5, 7],
                      [2, np.inf, 4, 8, 2],
                      [2, 4, np.inf, 1, 3],
                      [5, 8, 1, np.inf, 2],
                      [7, 2, 3, 2, np.inf]])

ant_colony = AntColony(distances, n_ants=3, n_best=1, n_iterations=100, decay=0.95, alpha=1, beta=1)
shortest_path = ant_colony.run()
print("Shortest path: {}".format(shortest_path))
```

Parameters

- `distances`: A 2D numpy array where the element at `[i][j]` represents the distance between node `i` and node `j`.
- `n_ants`: The number of ants to use in the simulation.
- `n_best`: The number of best ants who deposit pheromone.
- `n_iterations`: The number of iterations to run the simulation.
- `decay`: The rate at which pheromone decays.
- `alpha`: The importance of pheromone (default is 1).
- `beta`: The importance of distance (default is 1).

Classes and Methods

```
class AntColony
```

```
__init__(self, distances, n_ants, n_best, n_iterations, decay, alpha=1, beta=1)
```

Initializes the ant colony with the given parameters.

```
run(self)
```

Executes the ACO algorithm and returns the shortest path found.

```
spread_pheromone(self, all_paths, n_best, shortest_path)
```

Spreads pheromone on the paths taken by the ants.

```
gen_path_dist(self, path)
```

Generates the total distance for a given path.

```
gen_all_paths(self)
```

Generates all paths for all ants.

```
gen_path(self, start)
```

Generates a path for a single ant starting from the given start node.

```
pick_move(self, pheromone, dist, visited)
```

Picks the next move for an ant based on the pheromone levels and distances.

Example

The example provided demonstrates how to create an `AntColony` instance with a given distance matrix and run the optimization to find the shortest path.

```
import numpy as np

distances = np.array([[np.inf, 2, 2, 5, 7],
                      [2, np.inf, 4, 8, 2],
                      [2, 4, np.inf, 1, 3],
                      [5, 8, 1, np.inf, 2],
                      [7, 2, 3, 2, np.inf]])

ant_colony = AntColony(distances, n_ants=3, n_best=1, n_iterations=100, decay=0.95, alpha=1, beta=1)
shortest_path = ant_colony.run()
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```

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Acknowledgements

This implementation is based on the Ant Colony Optimization algorithm for solving the Traveling Salesman Problem. More information on the ACO algorithm can be found [here](#).

Feel free to contribute to this project by submitting issues or pull requests.

This `README` file provides an overview of the project, installation instructions, usage examples, and a brief explanation of the classes and methods. Adjustments can be made based on specific project requirements or preferences.