Traveling Salesman Problem Solution using Simulated Annealing

Introduction

The Traveling Salesman Problem (TSP) is a classic algorithmic problem in the fields of computer science and operations research. It involves finding the shortest possible route that visits a set of cities and returns to the origin city. This problem is known to be NP-hard, meaning that there is no known efficient solution for large problem instances. One of the heuristic methods to solve TSP is Simulated Annealing.

Working of the Code

1. **Input Loading:** The code starts by loading a dataset from a file ("tsp40.txt") containing the coordinates of 40 cities.
2. **Representation:** The cities are represented as (x, y) coordinates, stored in a NumPy array.
3. **Initial Solution:** A random initial order of cities is generated.
4. **Simulated Annealing:** The code uses Simulated Annealing algorithm to iteratively explore neighboring solutions. It swaps two cities and decides whether to accept the new solution based on the cost (total distance). The temperature `T` decreases over iterations, controlling the probability of accepting worse solutions. The process continues for a fixed number of iterations.
5. **Output:** The optimized order of visiting cities is obtained, and the total distance travelled is calculated.
6. **Visualization:** The optimized tour is plotted using Matplotlib to visualize the route.

Observations and Inferences

- The algorithm iteratively refines the solution, exploring various permutations of city orders.
- The `T` parameter controls the exploration-exploitation trade-off. Higher initial temperatures allow exploration of a broader solution space, while lower temperatures exploit the current solution to find the global optimum.
- The percentage improvement is calculated based on the initial guess of the solution.
- Simulated Annealing helps in escaping local minima by accepting worse solutions with a certain probability, which is crucial for finding the global optimum in complex search spaces.

Output

- **Optimum Distance Travelled:** The code outputs the optimum distance travelled by the salesman.
- **Percentage Improvement:** It also provides the percentage improvement over the initial guess.
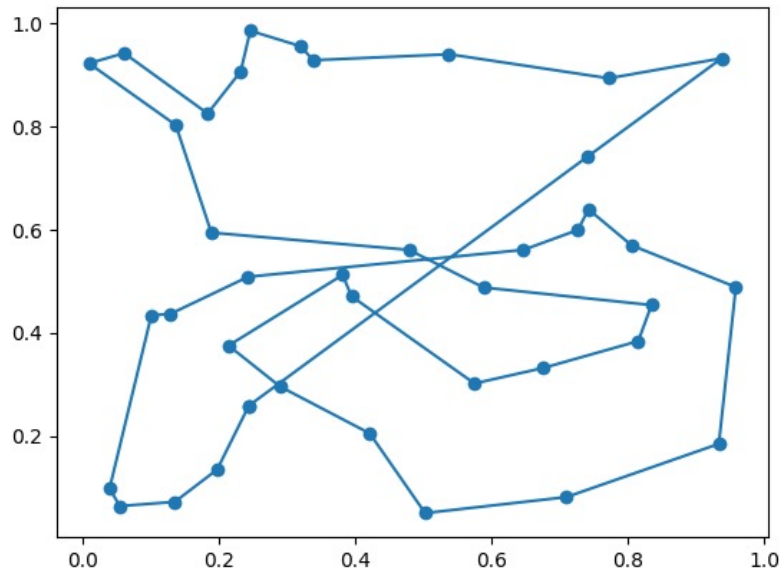- **Visualization:**

Figure 1: path.png

Conclusion

Simulated Annealing is a powerful optimization technique for solving combinatorial problems like the Traveling Salesman Problem. This code demonstrates how the algorithm can be applied to find an approximate solution for a given set of cities, optimizing the route the salesman should take to minimize the total distance travelled.

Note: Make sure to have the "tsp40.txt" file containing the city coordinates in the same directory as the Python script for the code to run successfully.