antcoloptm

November 20, 2024

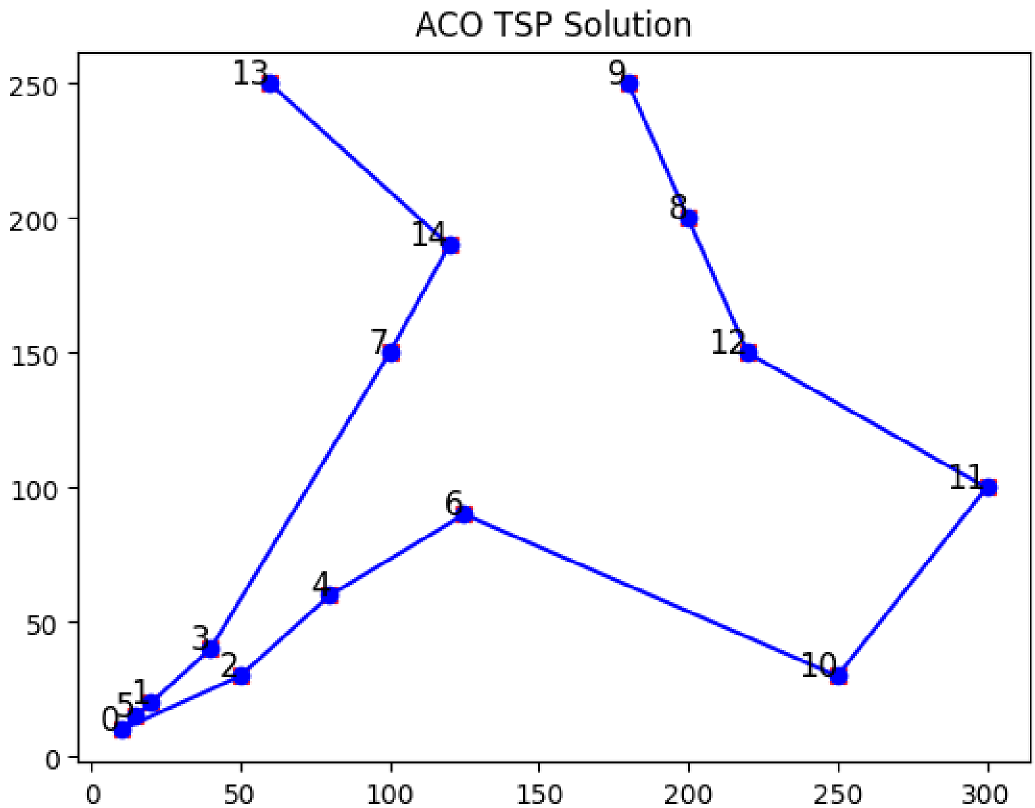
[ ]:
```
#Ant Colony Optimization algorithm to solve the Traveling Salesman Problem
print("Name:Sudarshan Komar","USN:1BM22CS291",sep="\n")

import numpy as np
import random
import matplotlib.pyplot as plt

NUM_ANTS = 50
ALPHA = 1.0  # Influence of pheromone
BETA = 2.0   # Influence of distance
RHO = 0.1    # Pheromone evaporation rate
Q = 100       # Pheromone deposit constant
MAX_ITER = 100  # Maximum number of iterations


def define_cities():
    return np.array([
        [10, 10],
        [20, 20],
        [50, 30],
        [40, 40],
        [80, 60],
        [15, 15],
        [125, 90],
        [100, 150],
        [200, 200],
        [180, 250],
        [250, 30],
        [300, 100],
        [220, 150],
        [60, 250],
        [120, 190],
    ])

# Compute the distance matrix
def compute_distance_matrix(cities):
    num_cities = len(cities)
```

```python
    distance_matrix = np.zeros((num_cities, num_cities))
    for i in range(num_cities):
        for j in range(i + 1, num_cities):
            dist = np.linalg.norm(cities[i] - cities[j])
            distance_matrix[i, j] = dist
            distance_matrix[j, i] = dist
    return distance_matrix

# Initialize pheromone matrix
def initialize_pheromone_matrix(num_cities):
    pheromone_matrix = np.ones((num_cities, num_cities))  # Pheromone starts as 1 for all edges
    np.fill_diagonal(pheromone_matrix, 0)  # No pheromone on the diagonal (self-loops)
    return pheromone_matrix

# Calculate the total length of a tour
def calculate_tour_length(tour, dist_matrix):
    length = 0
    for i in range(len(tour) - 1):
        length += dist_matrix[tour[i], tour[i + 1]]
    length += dist_matrix[tour[-1], tour[0]]  # Returning to the start
    return length

# Ant solution construction (probabilistic decision on next city)
def construct_solution(num_cities, pheromone_matrix, dist_matrix):
    tour = [random.randint(0, num_cities - 1)]  # Start from a random city
    visited = set(tour)

    while len(tour) < num_cities:
        current_city = tour[-1]
        probabilities = []
        for next_city in range(num_cities):
            if next_city not in visited:
                pheromone = pheromone_matrix[current_city, next_city] ** ALPHA
                distance = (1.0 / dist_matrix[current_city, next_city]) ** BETA
                probabilities.append(pheromone * distance)
            else:
                probabilities.append(0)

        total_prob = sum(probabilities)
        probabilities = [p / total_prob for p in probabilities]

        # Choose the next city based on the probabilities
        next_city = np.random.choice(range(num_cities), p=probabilities)
        tour.append(next_city)
        visited.add(next_city)
```

```python
    return tour

# Update the pheromone matrix based on the solutions found by ants
def update_pheromone(pheromone_matrix, all_tours, dist_matrix, best_tour):
    # Evaporate pheromone
    pheromone_matrix *= (1 - RHO)

    # Add pheromone for all ants
    for tour in all_tours:
        tour_length = calculate_tour_length(tour, dist_matrix)
        for i in range(len(tour) - 1):
            pheromone_matrix[tour[i], tour[i + 1]] += Q / tour_length
        pheromone_matrix[tour[-1], tour[0]] += Q / calculate_tour_length(tour, dist_matrix)

    # Add pheromone for the best tour
    best_length = calculate_tour_length(best_tour, dist_matrix)
    for i in range(len(best_tour) - 1):
        pheromone_matrix[best_tour[i], best_tour[i + 1]] += Q / best_length
    pheromone_matrix[best_tour[-1], best_tour[0]] += Q / best_length

# Main ACO algorithm for solving TSP
def ant_colony_optimization(cities, dist_matrix, pheromone_matrix, max_iter):
    best_tour = None
    best_tour_length = float('inf')

    # Main loop
    for iteration in range(max_iter):
        all_tours = []

        # Step 1: All ants construct their solutions
        for _ in range(NUM_ANTS):
            tour = construct_solution(len(cities), pheromone_matrix, dist_matrix)
            all_tours.append(tour)
            tour_length = calculate_tour_length(tour, dist_matrix)

            # Step 2: Update the best tour if necessary
            if tour_length < best_tour_length:
                best_tour = tour
                best_tour_length = tour_length

        # Step 3: Update pheromone matrix
        update_pheromone(pheromone_matrix, all_tours, dist_matrix, best_tour)

    return best_tour, best_tour_length
```

```python
# Visualize the tour
def plot_tour(cities, best_tour):
    tour_cities = cities[best_tour]
    plt.plot(tour_cities[:, 0], tour_cities[:, 1], 'bo-', markersize=6)
    plt.scatter(cities[:, 0], cities[:, 1], color='red', marker='x')
    for i, city in enumerate(cities):
        plt.text(city[0], city[1], f'{i}', fontsize=12, ha='right')
    plt.title("ACO TSP Solution")
    plt.show()

# Main Execution
if __name__ == "__main__":

    cities = define_cities()
    dist_matrix = compute_distance_matrix(cities)

    pheromone_matrix = initialize_pheromone_matrix(len(cities))

    best_tour, best_tour_length = ant_colony_optimization(cities, dist_matrix, pheromone_matrix, MAX_ITER)

    print(f"Best tour length: {best_tour_length:.2f}")
    plot_tour(cities, best_tour)
```

```
Name:Sudarshan Komar
USN:1BM22CS291
Best tour length: 985.25
```


ACO TSP Solution
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0
50
100
150
200
250
300