Optimization of vehicle routing problem using artificial bee colony algorithm

Advisor

Zack Butler

Author

Nikhil Keswaney

Problem Statement

Capacitated vehicle routing problem(CVRP) is a combinatorial optimization problem which states as follows:

“ Find the optimal delivery routes for a set of vehicles to supply the set of customers with given demands minimizing the total cost of all the routes.”

Constraints

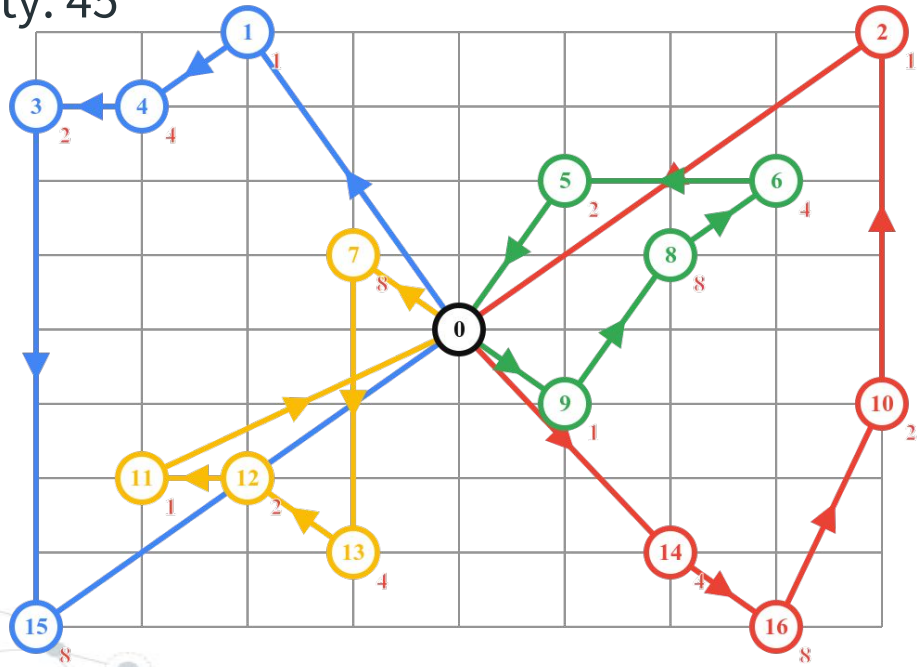
We have to find the optimal routes such that the following criterias are satisfied.

- N customers with demand of d_i
- There is a cost C_{ij} associated for going from i to j.
- K trucks with capacity of Q.
- Each customer should be visited exactly once.
- Each truck should start and end at a depot.

Example

Number of vehicles: 4

Vehicle Capacity: 45



Computational Complexity

- CVRP is an NP-hard problem
- The brute force algorithm has a factorial growth rate for possible solutions. Assuming the processor used for enumeration does around ~1 bi/sec following is the time taken

Problem Size (Number of Nodes)	*Approximate Solution Time*
10	3 milli-seconds
20	77 years
25	490 million years
30	$8.4*10^{15}$ years
50	$9.6*10^{47}$ years

Why solve CVRP?

- In US transportation related goods and services contributes to around $1156 billion i.e. 11% of the GDP
- Even a small percent of saving will yield a substantial saving
- VRP not only contributes to saving the transportation cost but also helps in environment protection by reducing the fuel utilization

Ways to solve CVRP.

1. **Exact algorithm**

   Finds the most optimal solution

1. **Approximate algorithm**

   These technique doesn’t guarantee the optimal solution

   Example: Hill climbing, simulated annealing, genetic algorithm, artificial bee colony algorithm … etc.

Artificial bee colony algorithm

- Approximation algorithm
- Foraging behaviour
- The position of the food source represents a possible solution to the problem
- The nectar amount represents the fitness of the solution.
- The number of employed bees represents the number of solutions

Milestones

1. Milestone 1 ✅
    a. Finding dataset
    b. Implementation of an exact algorithm
2. Milestone 2
    a. Implement an approximate algorithm(Artificial bee colony algorithm)
    b. Improve the performance of artificial bee colony algorithm
3. Milestone 3
    a. Parallelize the artificial bee colony algorithm
    b. Compare and contrast the run-time of all the implementations

Questions?

Thank you.