Project 2: Vehicle Routing Problem

1 Possible Point

19/10/2022

Attempt 1

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Unlimited Attempts Allowed

Details

Problem statement

The **capacitated vehicle routing problem (CVRP)** is a generalized version of the well-known **traveling salesman problem (TSP)**. We have **a set of vehicles** with a known capacity, **a set of customers** with known demand, and **a depot**. The location of the depot and customers are also known. **The objective** is to find a set of routes for the vehicles in a way that:

- the demand of customers is satisfied,
- capacity limitation of the vehicles is not exceeded,
- and the **total traveling distance** by the vehicles is minimized.

Note that **a route for a vehicle should start from the depot and end at the depot**.

What is your task?

- Design a structure to represent a solution to this problem and explain your representation method.
- Explain how you are dealing with the capacity limitation of the vehicles.
- Given the information below, implement a Genetic Algorithm or a Simulated Annealing in **C++** or **Python** to solve this problem (**note:** You need to code your algorithm in a way that it reports the total traveling cost and CPU time at each run).
- Ensure that you provide enough explanations regarding each element of your algorithm (for instance, if you are using GA what kind of mutation operators are applied, what is the selection method, what are the parameter values in your algorithm, etc.).
- Run your algorithm 30 times and report your results (including the total traveling cost and CPU time of each run).
- Report your best solution in detail (including the total cost, the routes, and the plot of the

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What to submit?

In this project, you need to **submit**:

1. **a short report in a maximum of two pages addressing the above questions.**
2. **your source code.**

Evaluation criteria

Your project is **evaluated** based on the following criteria:

- In **20 independent runs**, your best solution shouldn't be worse than **10% of the optimal solution** (the optimal solution is shown at the end of this page),
- In **20 independent runs**, the overall CPU time shouldn't exceed **200 seconds** on an average CPU with a base clock of 2.5GHz.
- your report properly addresses the requested questions.

Dataset

Assume that you have **9 vehicles** each with a **capacity of 100 units**. The following table gives the coordinate and demand information of the nodes (**node 1 is the depot**, and the rest are customers).

Node	Demand	x-coordinate	y-coordinate	Node	Demand	x-coordinate	y-coordinate
1	0	36	64	**29**	22	60	89
2	3	94	47	**30**	7	58	68
3	12	10	23	**31**	11	30	93
4	25	16	46	**32**	15	9	60
5	4	25	79	**33**	22	47	44
6	11	41	30	**34**	12	19	40
7	20	81	45	**35**	24	15	40
8	21	14	79	**36**	25	88	21
9	10	42	56	**37**	2	33	58

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11	13	41	39
12	14	21	14
13	16	41	46
14	17	65	96
15	11	13	49
16	36	21	14
17	6	57	2
18	7	14	42
19	21	66	62
20	11	58	96
21	17	5	51
22	22	41	50
23	10	50	99
24	19	84	85
25	21	97	90
26	23	47	76
27	19	11	54
28	15	60	97
39	18	57	7
40	13	81	6
41	3	49	6
42	20	51	78
43	14	9	62
44	10	84	36
45	10	95	76
46	66	89	44
47	10	10	49
48	7	69	16
49	12	75	66
50	24	97	11
51	5	74	69
52	18	1	14
53	7	96	91
54	11	46	22
55	12	74	92

Note: use direct distance metric to calculate the distance between nodes i and j, that is: $d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$.

Optimal solution

Below you can find the **optimal solution** for the given instance, where the **total traveling distance is 1073**:

Route #1: 4 7 42 31 20 46 26

Route #2: 36 11 15 51 2 17 14

[illegible]

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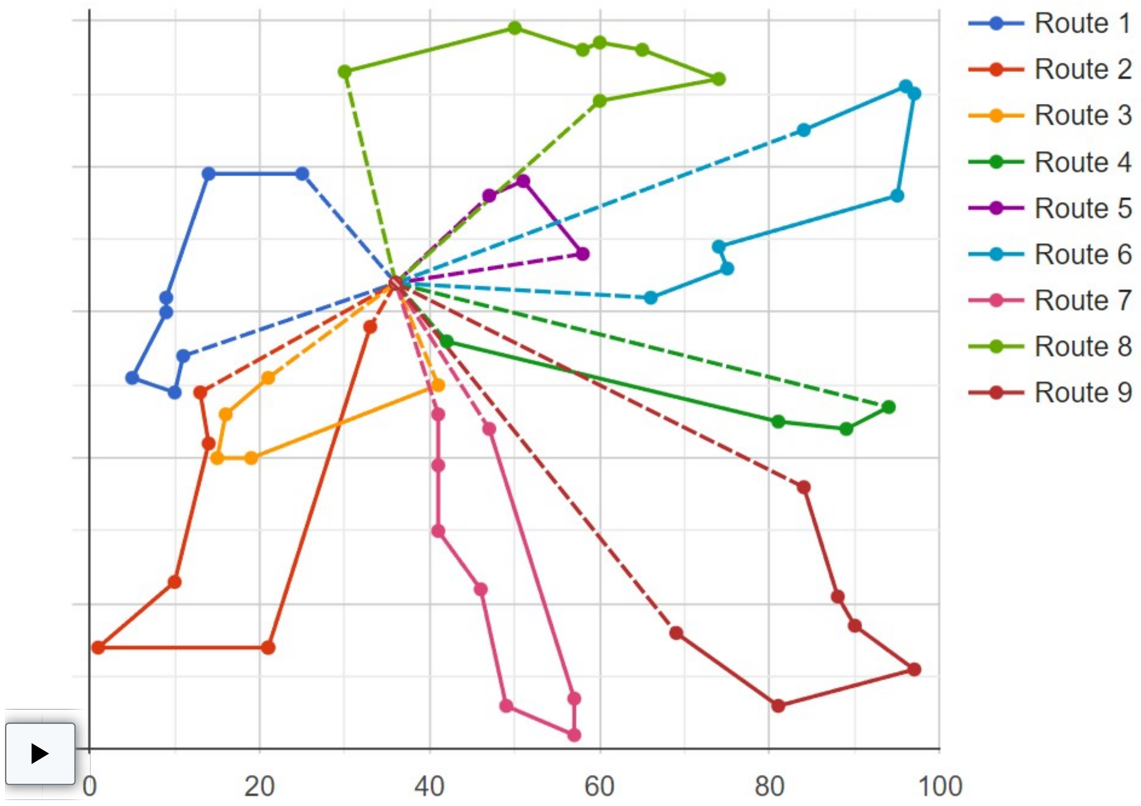
Route #5: 25 41 29

Route #6: 23 52 24 44 50 48 18

Route #7: 32 38 16 40 53 5 10 12

Route #8: 30 22 19 27 13 54 28

Route #9: 47 39 49 9 35 43



Optimal routes plot

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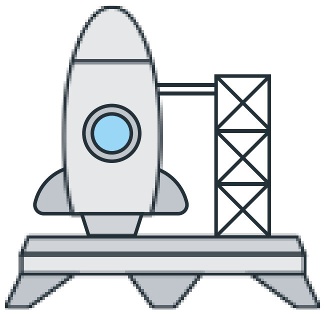

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