

The Application of Greedy Randomized Adaptive Search Procedure (GRASP) for Vehicle Routing Optimization

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Abstract. This research aimed to optimize vehicle routing of manufacturer by application of Greedy Randomized Adaptive Search Procedure (GRASP). This methodology was used to find out the shortest distance and increase the highest vehicle routing efficiency. The manufacturer had several kinds of products such as mold, jig, fixture, auto parts and machine parts. Customers, trading regularly for a period of 6 months, had 8 for the case study. Performance indicator of vehicle routing was shortest distance by comparison the results of Greedy Randomized Adaptive Search Procedure and employee experience. The results showed that the transportation distance was reduced by 95.4 km per day, from 602 km per day to be 506.6 km per day or 15.85%. Moreover Using pickups were reduced from 3 pickups per day to be 2 pickups per day.

Keywords— Heuristic, Routing, Greedy, Vehicle.

INTRODUCTION

This manufacturer has several kinds of products such as mold, jig and fixture, auto parts and machine parts. Manufacturer will deliver products to 8 customers every day. Researcher wants to optimize vehicle routing of manufacturer in table 1 by application of Greedy Randomized Adaptive Search Procedure (GRASP).

Table 1: Present route

Car	Route	Distance (km)
Pick up 1	0-1-2-3-4-0	88.3
Pick up 2	0-5-6-0	127.7
Pick up 3	0-7-8-0	386
Total		602

LITERATURE AND THEORY

There are 2 steps for application of Greedy Randomized Adaptive Search Procedure (GRASP)

Initial Solution

This method, initial solution, will consider possible answers that do not conflict with the condition. Route selection and adding customers in route will consider weight, size, time window and other.

Improvement Solution

This method, improvement solution, will choose best solution from initial solution and improve solution by using swap customer method and move exchange method.

RESEARCH METHODOLOGY

Creating Initial Solution

1.1 Input information such as customer detail, demand, condition number of cars and other. This case study does not have special conditions.

1.2 Find distance from manufacturer to customers and show them in table 2.

Table 2: Distance table

	0	1	2	3	4	5	6	7	8
0		10.9	17.1	19	27.6	33.8	35.9	125	153
1	10.9		11.2	21.9	24.1	36.6	33.1	120	133
2	17.1	11.2		26	16.6	40.7	22.4	108	141
3	19	21.9	26		40.2	19.3	48.1	128	156
4	27.6	24.1	16.6	40.2		49.3	11.5	103	138
5	33.8	36.6	40.7	19.3	49.3		58	138	149
6	35.9	33.1	22.4	48.1	11.5	58		96	145
7	125	120	108	128	103	138	96		108
8	153	133	141	156	138	149	145	108	

1.3 Select one closest customer, include the distance of the selected customer to the next customer, initialize $i=10\%$. Finally, create route by selecting total distance of customer which less than value of $i=10\%$ in table 3.

Table 3: Sample calculation

		1	2	3	4	5	6	7	8
			11.2	21.9	24.1	36.6	33.1	120	133
	10.9		22.1	32.8	35	47.5	44	130.9	143.9
			33.3	54.7	59.1	84.1	77.1	250.9	276.9
Route1 : 0-1-2-0	$i=10\%$		36.63						

		1	2	3	4	5	6	7	8
					40.2	19.3	48.1	128	156
				19	59.2	38.3	67.1	147	175
					78.2	57.3	86.1	166	194
Route2 : 0-3-4-5-6-0	$i=10\%$				86.02				

		1	2	3	4	5	6	7	8
									108
								125	233
Route3: 0-7-8-0	$i=10\%$							233	

1.4 Add value $i=20\%, 30\% \dots 100\%$.

Improvement Solution

2.1 Swap customer by choosing best solution of i , minimum distance, from initial solution and swap customer in route.

2.2 Move exchange by moving a customer from one route to another.

RESULTS

4.1 The results of initial solution showed that $i=100\%$ has minimum total distance in table 4.

Table 4: The results of initial solution

i	Route	Distance	Total Distance
10%	0-1-2-0	39.2	627.6
	0-3-4-5-6-0	202.4	
	0-7-8-0	386	
20%	0-1-2-0	39.2	627.6
	0-3-4-5-6-0	202.4	
	0-7-8-0	386	
30%	0-1-2-0	39.2	627.6
	0-3-4-5-6-0	202.4	
	0-7-8-0	386	
40%	0-1-2-0	39.2	627.6
	0-3-4-5-6-0	202.4	
	0-7-8-0	386	
50%	0-1-2-0	39.2	627.6
	0-3-4-5-6-0	202.4	
	0-7-8-0	386	
60%	0-1-2-0	39.2	627.6
	0-3-4-5-6-0	202.4	
	0-7-8-0	386	
70%	0-1-2-3-0	67.1	729
	0-4-5-6-7-0	355.9	
	0-8-0	306	

80%	0-1-2-3-4-0	88.3	602
	0-5-6-0	127.7	
	0-7-8-0	386	
90%	0-1-2-3-4-0	88.3	707.1
	0-5-6-7-0	312.8	
	0-8-0	306	
100%	0-1-2-3-4-0	115.9	564.7
	0-5-6-7-8-0	448.8	

4.2 The results of swapping customer showed that 0-1-2-4-3-0 and 0-5-8-7-6-0 have minimum total distance in table 5.

Table 5: The results of swapping customer

Route	Swap Customer										Total distance	
0-1-2-3-4-0	0	-	1	-	2	-	3	-	4	-	0	115.9
	0	-	2	-	1	-	3	-	4	-	0	118
	0	-	3	-	2	-	1	-	4	-	0	107.9
	0	-	4	-	2	-	3	-	1	-	0	103
	0	-	1	-	3	-	2	-	4	-	0	103
	0	-	1	-	4	-	3	-	2	-	0	118.3
	0	-	1	-	2	-	4	-	3	-	0	97.9
0-5-6-7-8-0	0	-	5	-	6	-	7	-	8	-	0	448.8
	0	-	6	-	5	-	7	-	8	-	0	492.9
	0	-	7	-	6	-	5	-	8	-	0	581
	0	-	8	-	6	-	7	-	5	-	0	565.8
	0	-	5	-	7	-	6	-	8	-	0	565.8
	0	-	5	-	8	-	7	-	6	-	0	422.7
	0	-	5	-	6	-	8	-	7	-	0	469.8

4.3 The results of moving exchanges showed that 0-1-2-5-3-0 and 0-4-8-7-6-0 have minimum total distance in table 6.

Table 6: The results of moving exchanges

Swap	Move Exchanges										Total distance	
	0	-	1	-	2	-	4	-	3	-	0	520.6
	0	-	5	-	8	-	7	-	6	-	0	
1-5	0	-	5	-	2	-	4	-	3	-	0	534.1
	0	-	1	-	8	-	7	-	6	-	0	
1-8	0	-	8	-	2	-	4	-	3	-	0	692.1
	0	-	5	-	1	-	7	-	6	-	0	
1-7	0	-	7	-	2	-	4	-	3	-	0	693.6
	0	-	5	-	8	-	1	-	6	-	0	
1-6	0	-	6	-	2	-	4	-	3	-	0	555.8
	0	-	5	-	8	-	7	-	1	-	0	
2-5	0	-	1	-	5	-	4	-	3	-	0	554
	0	-	2	-	8	-	7	-	6	-	0	
2-8	0	-	1	-	8	-	4	-	3	-	0	655.5
	0	-	5	-	2	-	7	-	6	-	0	
2-7	0	-	1	-	7	-	4	-	3	-	0	675.2
	0	-	5	-	8	-	2	-	6	-	0	

2-6	0	-	1	-	6	-	4	-	3	-	0	530.6
	0	-	5	-	8	-	7	-	2	-	0	
4-5	0	-	1	-	2	-	5	-	3	-	0	506.6
	0	-	4	-	8	-	7	-	6	-	0	
4-8	0	-	1	-	2	-	8	-	3	-	0	656.1
	0	-	5	-	4	-	7	-	6	-	0	
4-7	0	-	1	-	2	-	7	-	3	-	0	645.3
	0	-	5	-	8	-	4	-	6	-	0	
4-6	0	-	1	-	2	-	6	-	3	-	0	533
	0	-	5	-	8	-	7	-	4	-	0	
3-5	0	-	1	-	2	-	4	-	5	-	0	536.7
	0	-	3	-	8	-	7	-	6	-	0	
3-8	0	-	1	-	2	-	4	-	8	-	0	642.7
	0	-	5	-	3	-	7	-	6	-	0	
3-7	0	-	1	-	2	-	4	-	7	-	0	689.5
	0	-	5	-	8	-	3	-	6	-	0	
3-6	0	-	1	-	2	-	4	-	6	-	0	523.9
	0	-	5	-	8	-	7	-	3	-	0	

4.4 The results of comparison showed that new routes have 506.6 km. and use 2 pickups in table 7.

Table 7: The results of comparison

Present Route			New Route		
Car	Route	Distance (km)	Car	Route	Distance (km)
Pickup 1	0-1-2-3-4-0	88.3	Pickup 1	0-1-2-5-3-0	101.1
Pickup 2	0-5-6-0	127.7	Pickup 2	0-4-8-7-6-0	405.5
Pickup 3	0-7-8-0	386			
Total		602	Total		506.6

CONCLUSION

Present route have 602 km. and use 3 pickups. New routes have 506.6 km. and use 2 pickups. So, new route can reduce total distance from 602 km to 506.6 km or the transportation distances are reduced by 95.4 km per day. Using pickups are reduced from 3 pickups to 2 pickups.

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