Task Assignment

Metaheuristics | 2023

Maximum number of points: 25

In the **capacitated vehicle routing problem with time-windows (CVRPTW)**, a fleet of delivery vehicles with uniform capacity must service customers with known demand and opening hours for a single commodity. The vehicles start and end their routes at a common depot. Each customer can only be served by one vehicle. The objectives are to minimize the fleet size and assign a sequence of customers to each truck of the fleet minimizing the total distance travelled such that all customers are served and the total demand served by each truck does not exceed its capacity.

Each student is requested implementing a command-line application in Java or Python to solve a given CVRPTW using Genetic Algorithms (GA), and Ant Colony Optimization (ACO) or Particle Swarm Optimization (PSO).

Genetic Algorithm is **mandatory**.
One of Ant Colony Optimization **or** Particle Swarm Optimization are mandatory, not both.

After finishing the project/implementation a complete **archive [student_id]_[student_name].zip** must be created and **uploaded to Vula latest until October 24th 2023**.

Specification

Programming language and IDE	
Programming language	Oracle JDK/JRE 17.0.8 (LTS) **or** Python 3.11.5
Random Generator	
MersenneTwister (http://www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/emt.html)	
Knapsack data instance [knapsack_instance.csv]	
Number of customer	100
Maximum vehicle capacity	200
Maximum number of iterations	10000
Best-known optimum	1646
Command-line	
General	Command-line arguments in any arrangements
-**algorithm** [ga | [aco | pso]]	Specification of algorithm used for optimization. Genetic Algorithm is mandatory. One of Ant Colony Optimization or Particle Swarm Optimization are mandatory, not both. An existing configuration file with best parameter configuration, e.g. ga_best.json will be automatically loaded.
-**search_best_configuration** [ga | [aco | pso]]	Search for the best configuration.

Scores (maximum 25 points)

(1st week) **Genetic Algorithm**	**Algorithm** [8 points] Elitism must be implemented. Behaviour (selection, crossover, mutation) and steps must be documented **meaningful** in a **log** file with timestamp in nanoseconds. For every five percent deviation from the best-known optimum, 1 point is deducted. Example | Found optimum: 1810, 2 points are deducted. **Test Management** (2 points) Meaningful tests based on JUnit 5[1].
(2nd week) **Particle Swarm Optimization** or **Ant Colony Optimization**	**Algorithm** [8 points] **Search by agents must be parallelised.** Behaviour of the agents and steps must be documented **meaningful** in a **log** file with timestamp in nanoseconds. 5 points are deducted if no concurrency is implemented. For every five percent deviation from the best-known optimum, 1 point is deducted. Example | Found optimum: 1810, 2 points are deducted. **Test Management** (2 points) Meaningful tests based on JUnit 5.
(3rd week) **Parameter Recommender**	**Parameter Recommender** [5 Points] Recommender is implemented for the parameter optimization, which determines an optimal setup. The best parameter configuration for each algorithm is stored in a file [algorithm]_best.json.

[1] https://junit.org/junit5/docs/current/user-guide/

Data Instance

CUST NO.	XCOORD.	YCOORD.	DEMAND	READY TIME	DUE DATE	SERVICE TIME
1	35.00	35.00	0.00	0.00	230.00	0.00
2	41.00	49.00	10.00	161.00	171.00	10.00
3	35.00	17.00	7.00	50.00	60.00	10.00
4	55.00	45.00	13.00	116.00	126.00	10.00
5	55.00	20.00	19.00	149.00	159.00	10.00
6	15.00	30.00	26.00	34.00	44.00	10.00
7	25.00	30.00	3.00	99.00	109.00	10.00
8	20.00	50.00	5.00	81.00	91.00	10.00
9	10.00	43.00	9.00	95.00	105.00	10.00
10	55.00	60.00	16.00	97.00	107.00	10.00
11	30.00	60.00	16.00	124.00	134.00	10.00
12	20.00	65.00	12.00	67.00	77.00	10.00
13	50.00	35.00	19.00	63.00	73.00	10.00
14	30.00	25.00	23.00	159.00	169.00	10.00
15	15.00	10.00	20.00	32.00	42.00	10.00
16	30.00	5.00	8.00	61.00	71.00	10.00
17	10.00	20.00	19.00	75.00	85.00	10.00
18	5.00	30.00	2.00	157.00	167.00	10.00
19	20.00	40.00	12.00	87.00	97.00	10.00
20	15.00	60.00	17.00	76.00	86.00	10.00
21	45.00	65.00	9.00	126.00	136.00	10.00
22	45.00	20.00	11.00	62.00	72.00	10.00
23	45.00	10.00	18.00	97.00	107.00	10.00
24	55.00	5.00	29.00	68.00	78.00	10.00
25	65.00	35.00	3.00	153.00	163.00	10.00
26	65.00	20.00	6.00	172.00	182.00	10.00
27	45.00	30.00	17.00	132.00	142.00	10.00
28	35.00	40.00	16.00	37.00	47.00	10.00
29	41.00	37.00	16.00	39.00	49.00	10.00
30	64.00	42.00	9.00	63.00	73.00	10.00
31	40.00	60.00	21.00	71.00	81.00	10.00
32	31.00	52.00	27.00	50.00	60.00	10.00
33	35.00	69.00	23.00	141.00	151.00	10.00
34	53.00	52.00	11.00	37.00	47.00	10.00
35	65.00	55.00	14.00	117.00	127.00	10.00
36	63.00	65.00	8.00	143.00	153.00	10.00
37	2.00	60.00	5.00	41.00	51.00	10.00
38	20.00	20.00	8.00	134.00	144.00	10.00
39	5.00	5.00	16.00	83.00	93.00	10.00
40	60.00	12.00	31.00	44.00	54.00	10.00
41	40.00	25.00	9.00	85.00	95.00	10.00
42	42.00	7.00	5.00	97.00	107.00	10.00
43	24.00	12.00	5.00	31.00	41.00	10.00
44	23.00	3.00	7.00	132.00	142.00	10.00
45	11.00	14.00	18.00	69.00	79.00	10.00
46	6.00	38.00	16.00	32.00	42.00	10.00
47	2.00	48.00	1.00	117.00	127.00	10.00
48	8.00	56.00	27.00	51.00	61.00	10.00
49	13.00	52.00	36.00	165.00	175.00	10.00
50	6.00	68.00	30.00	108.00	118.00	10.00
51	47.00	47.00	13.00	124.00	134.00	10.00
52	49.00	58.00	10.00	88.00	98.00	10.00
53	27.00	43.00	9.00	52.00	62.00	10.00
54	37.00	31.00	14.00	95.00	105.00	10.00
55	57.00	29.00	18.00	140.00	150.00	10.00
56	63.00	23.00	2.00	136.00	146.00	10.00
57	53.00	12.00	6.00	130.00	140.00	10.00
58	32.00	12.00	7.00	101.00	111.00	10.00
59	36.00	26.00	18.00	200.00	210.00	10.00
60	21.00	24.00	28.00	18.00	28.00	10.00
61	17.00	34.00	3.00	162.00	172.00	10.00

62	12.00	24.00	13.00	76.00	86.00	10.00
63	24.00	58.00	19.00	58.00	68.00	10.00
64	27.00	69.00	10.00	34.00	44.00	10.00
65	15.00	77.00	9.00	73.00	83.00	10.00
66	62.00	77.00	20.00	51.00	61.00	10.00
67	49.00	73.00	25.00	127.00	137.00	10.00
68	67.00	5.00	25.00	83.00	93.00	10.00
69	56.00	39.00	36.00	142.00	152.00	10.00
70	37.00	47.00	6.00	50.00	60.00	10.00
71	37.00	56.00	5.00	182.00	192.00	10.00
72	57.00	68.00	15.00	77.00	87.00	10.00
73	47.00	16.00	25.00	35.00	45.00	10.00
74	44.00	17.00	9.00	78.00	88.00	10.00
75	46.00	13.00	8.00	149.00	159.00	10.00
76	49.00	11.00	18.00	69.00	79.00	10.00
77	49.00	42.00	13.00	73.00	83.00	10.00
78	53.00	43.00	14.00	179.00	189.00	10.00
79	61.00	52.00	3.00	96.00	106.00	10.00
80	57.00	48.00	23.00	92.00	102.00	10.00
81	56.00	37.00	6.00	182.00	192.00	10.00
82	55.00	54.00	26.00	94.00	104.00	10.00
83	15.00	47.00	16.00	55.00	65.00	10.00
84	14.00	37.00	11.00	44.00	54.00	10.00
85	11.00	31.00	7.00	101.00	111.00	10.00
86	16.00	22.00	41.00	91.00	101.00	10.00
87	4.00	18.00	35.00	94.00	104.00	10.00
88	28.00	18.00	26.00	93.00	103.00	10.00
89	26.00	52.00	9.00	74.00	84.00	10.00
90	26.00	35.00	15.00	176.00	186.00	10.00
91	31.00	67.00	3.00	95.00	105.00	10.00
92	15.00	19.00	1.00	160.00	170.00	10.00
93	22.00	22.00	2.00	18.00	28.00	10.00
94	18.00	24.00	22.00	188.00	198.00	10.00
95	26.00	27.00	27.00	100.00	110.00	10.00
96	25.00	24.00	20.00	39.00	49.00	10.00
97	22.00	27.00	11.00	135.00	145.00	10.00
98	25.00	21.00	12.00	133.00	143.00	10.00
99	19.00	21.00	10.00	58.00	68.00	10.00
100	20.00	26.00	9.00	83.00	93.00	10.00
101	18.00	18.00	17.00	185.00	195.00	10.00