A Two-Stage Hybrid Local Search for the Pickup and Delivery Vehicle Routing Problem with Time Windows

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Appendix

This is the appendix for the paper *A Two-Stage Hybrid Local Search for the Pickup and Delivery Vehicle Routing Problem with Time Windows* appearing in the Proceedings of The Principles and Practice of Constraint Programming, 2003 (CP2003). Due to space constraints, some results went unreported in the proceedings. In addition, during the time period between submission and publication new results from [2] and [4] were reported.

Table 1 groups the problems by their customer size and indicates how many of our results improved and equaled the best known solutions. We also report the results with respect to the new results of [2], [4], and [3]. Tables 2-7 show our best results compared to the best known results. In these tables LL=[1], SAM = [2], TS = [4], and SR=[3]. Results in boldface type indicate improvements over the best known solutions. All results are the best of 5 independent runs on each problem in the 100 customer set and 10 independent runs for the other problem sets. For the 100 and 200 customer benchmarks, the simulated annealing algorithm was run for 5 minutes and the LNS for a maximum of 60 minutes. For the 400 and 600 customer benchmarks, the simulated annealing algorithm was run for 10 minutes and the LNS for a maximum of 90 minutes. For the 800 and 1000 customer benchmarks, the simulated annealing algorithm was run for 15 minutes and the LNS for 120 minutes. All times are in CPU minutes and are reported for the LNS portion of the algorithm only. All results are given on a 1.2Ghz AMD Athlon Thunderbird K7 processor running Linux and compiled using g++ with the -O flag. All numbers used were double precision floating points. The results reported here are rounded to six significant digits for space.

	Overall				Routes			
	Original		w/ New Results		Original		w/ New Results	
	$<$	$\leq$	$<$	$\leq$	$<$	$\leq$	$<$	$\leq$
100	2 (4%)	54 (96%)	2 (4%)	54 (96%)	0 (0%)	56 (100%)	0 (0%)	56 (100%)
200	28 (47%)	52 (87%)	9 (15%)	34 (57%)	16 (27%)	60 (100%)	3 (5%)	53 (88%)
400	43 (72%)	49 (82%)	11 (18%)	21 (35%)	23 (38%)	59 (98%)	4 (7%)	33 (55%)
600	46 (77%)	51 (85%)	22 (37%)	28 (47%)	27 (45%)	58 (97%)	5 (8%)	44 (73%)
800	46 (77%)	51 (85%)	19 (32%)	24 (40%)	39 (65%)	57 (95%)	5 (8%)	33 (55%)
1000	35 (60%)	36 (62%)	13 (22%)	18 (31%)	28 (42%)	40 (69%)	3 (5%)	25 (43%)

Table 1: Results Analysis

	Best			LNS				Best			LNS		
	V	TD	Pub	V	TD	Time		V	TD	Pub	V	TD	Time
lc101	10	828.937	LL	10	828.937	0.00	lc201	3	591.557	LL	3	591.557	0.00
lc102	10	828.937	LL	10	828.937	0.00	lc202	3	591.557	LL	3	591.557	0.00
lc103	9	1042.00	SAM	**9**	**1035.35**	0.02	lc203	3	585.564	LL	3	591.173	0.00
lc104	9	860.011	SAM	9	860.011	0.33	lc204	3	590.599	SAM	3	590.599	4.47
lc105	10	828.937	LL	10	828.937	0.00	lc205	3	588.876	LL	3	588.876	0.00
lc106	10	828.937	LL	10	828.937	0.00	lc206	3	588.493	LL	3	588.493	0.00
lc107	10	828.937	LL	10	828.937	0.01	lc207	3	588.286	LL	3	588.286	0.00
lc108	10	826.439	LL	10	826.439	0.00	lc208	3	588.324	LL	3	588.324	0.00
lc109	9	1046.56	LL	**9**	**1000.60**	42.57							
lr101	19	1650.80	LL	19	1650.80	0.00	lr201	4	1253.23	SAM	4	1253.23	0.01
lr102	17	1487.57	LL	17	1487.57	0.01	lr202	3	1197.67	LL	3	1197.67	0.01
lr103	13	1292.68	LL	13	1292.68	0.01	lr203	3	949.396	LL	3	949.396	0.13
lr104	9	1013.39	LL	9	1013.39	0.00	lr204	2	849.05	LL	2	849.05	0.53
lr105	14	1377.11	SAM	14	1377.11	0.00	lr205	3	1054.02	LL	3	1054.02	0.01
lr106	12	1252.62	LL	12	1252.62	0.00	lr206	3	931.625	LL	3	931.625	0.78
lr107	10	1111.31	LL	10	1111.31	0.00	lr207	2	903.056	LL	2	903.056	0.01
lr108	9	968.966	LL	9	968.966	0.00	lr208	2	734.848	LL	2	734.848	0.01
lr109	11	1208.96	SAM	11	1208.96	0.00	lr209	3	930.586	SAM	3	930.586	12.97
lr110	10	1159.35	LL	10	1159.35	0.00	lr210	3	964.224	LL	3	964.224	0.04
lr111	10	1108.90	LL	10	1108.90	0.00	lr211	2	911.52	SAM	2	913.837	1.23
lr112	9	1003.77	LL	9	1003.77	0.00							
lrc101	14	1708.70	LL	14	1708.70	0.00	lrc201	4	1406.94	SAM	4	1406.94	0.14
lrc102	12	1558.07	SAM	12	1558.07	0.00	lrc202	3	1374.27	LL	3	1374.27	0.01
lrc103	11	1258.74	LL	11	1258.74	0.00	lrc203	3	1089.07	LL	3	1089.07	0.01
lrc104	10	1128.40	LL	10	1128.40	0.01	lrc204	3	818.67	SAM	3	818.663	0.18
lrc105	13	1637.62	LL	13	1637.62	0.00	lrc205	4	1302.20	LL	4	1302.20	0.05
lrc106	11	1424.73	SAM	11	1424.73	0.00	lrc206	3	1159.03	SAM	3	1159.03	0.01
lrc107	11	1230.14	LL	11	1230.14	0.00	lrc207	3	1062.05	SAM	3	1062.05	0.05
lrc108	10	1147.43	SAM	10	1147.43	0.00	lrc208	3	852.758	LL	3	852.758	0.11

Table 2: 100 Customers

	Best			LNS				Best			LNS		
	V	TD	Pub	V	TD	Time		V	TD	Pub	V	TD	Time
lc1_2_1	20	2704.57	LL	20	2704.57	0.00	lc2_2_1	6	1931.44	LL	6	1931.44	0.00
lc1_2_2	19	2764.56	LL	19	2764.56	0.05	lc2_2_2	6	1881.40	LL	6	1881.40	0.05
lc1_2_3	17	3128.61	SR	17	3134.08	26.78	lc2_2_3	6	1844.33	SAM	6	1844.33	0.64
lc1_2_4	17	2698.73	TS	**17**	**2693.41**	14.29	lc2_2_4	6	1767.12	LL	6	1767.12	5.76
lc1_2_5	20	2702.05	LL	20	2702.05	0.00	lc2_2_5	6	1891.21	LL	6	1891.21	0.00
lc1_2_6	20	2701.04	LL	20	2701.04	0.00	lc2_2_6	6	1857.78	SAM	6	1857.78	0.02
lc1_2_7	20	2701.04	LL	20	2701.04	0.05	lc2_2_7	6	1850.13	SAM	6	1850.13	0.01
lc1_2_8	20	2689.83	LL	20	2689.83	0.06	lc2_2_8	6	1824.34	LL	6	1824.34	2.65
lc1_2_9	18	2724.24	LL	18	2724.24	0.36	lc2_2_9	6	1854.21	SAM	6	1854.21	1.32
lc1_2_10	17	2974.00	SR	18	2741.56	1.00	lc2_2_10	6	1817.45	SAM	6	1817.45	0.27
lr1_2_1	20	4819.12	LL	20	4819.12	0.28	lr2_2_1	5	4073.10	SAM	5	4073.10	1.58
lr1_2_2	17	4621.21	SR	17	4658.92	1.12	lr2_2_2	4	3796.00	SAM	4	3796.00	1.58
lr1_2_3	15	3612.64	TS	15	3644.87	31.03	lr2_2_3	4	3098.36	SAM	4	3100.38	46.49
lr1_2_4	10	3037.38	SR	10	3089.86	58.34	lr2_2_4	3	2486.14	SR	3	2737.22	30.97
lr1_2_5	17	4331.14	SAM	**16**	**4760.18**	5.22	lr2_2_5	4	3438.39	SAM	4	3438.39	2.46
lr1_2_6	14	4201.92	SAM	**14**	**4175.16**	2.03	lr2_2_6	4	3201.54	LL	4	3208.53	16.74
lr1_2_7	12	3550.61	SR	12	3851.36	7.12	lr2_2_7	3	3169.89	SR	3	3337.28	41.52
lr1_2_8	9	2790.40	SR	9	2828.09	41.18	lr2_2_8	2	2555.40	SR	3	2364.28	42.49
lr1_2_9	14	4396.86	SR	14	4411.54	37.14	lr2_2_9	4	3198.44	SAM	4	3198.44	1.59
lr1_2_10	11	3714.16	SR	11	3744.95	4.35	lr2_2_10	3	3344.08	SR	3	3470.73	5.23
lrc1_2_1	19	3606.06	SAM	19	3606.06	0.04	lrc2_2_1	6	3605.40	SR	6	3690.10	10.80
lrc1_2_2	16	3519.33	SAM	**15**	**3673.19**	1.89	lrc2_2_2	5	3344.56	SR	6	2666.01	0.41
lrc1_2_3	13	3251.38	TS	**13**	**3161.75**	27.06	lrc2_2_3	4	2938.28	SR	4	3249.36	58.81
lrc1_2_4	10	2631.82	SR	**10**	**2655.27**	10.67	lrc2_2_4	3	2887.97	SR	4	2795.70	4.94
lrc1_2_5	16	3722.30	TS	**16**	**3715.81**	2.20	lrc2_2_5	5	2779.17	SAM	**5**	**2776.93**	2.38
lrc1_2_6	17	3368.66	SAM	17	3368.66	0.27	lrc2_2_6	5	2707.96	SAM	5	2707.96	0.09
lrc1_2_7	14	3668.72	SR	15	3417.16	17.17	lrc2_2_7	5	2544.27	SAM	**4**	**3050.03**	16.67
lrc1_2_8	13	3221.82	SR	13	3226.17	1.60	lrc2_2_8	4	2399.95	SR	4	2400.19	52.64
lrc1_2_9	13	3227.12	SR	14	3129.65	20.97	lrc2_2_9	4	2208.49	SR	4	2750.30	23.75
lrc1_2_10	12	2951.29	SR	13	2833.85	56.06	lrc2_2_10	3	2550.56	SR	3	2699.55	31.46

Table 3: 200 Customers

	Best			LNS				Best			LNS		
	V	TD	Pub	V	TD	Time		V	TD	Pub	V	TD	Time
lc1_4_1	40	7152.06	SAM	40	7152.06	0.00	lc2_4_1	12	4116.33	LL	12	4116.33	0.0
lc1_4_2	40	7151.26	SAM	**39**	**7326.93**	0.97	lc2_4_2	12	4144.29	SAM	12	4144.29	1.08
lc1_4_3	33	8374.26	SR	34	8392.37	13.49	lc2_4_3	12	4431.75	SR	12	4507.53	80.95
lc1_4_4	30	6451.68	LL	30	6952.59	84.17	lc2_4_4	12	3743.95	LL	12	4351.37	89.42
lc1_4_5	40	7150.00	SAM	40	7150.00	0.15	lc2_4_5	12	4030.63	TS	12	4030.63	2.11
lc1_4_6	40	7154.02	LL	40	7154.02	0.26	lc2_4_6	12	3900.29	SAM	12	3900.29	0.60
lc1_4_7	40	7149.43	SAM	40	7149.43	0.57	lc2_4_7	12	3965.86	SAM	**12**	**3962.51**	19.92
lc1_4_8	39	7111.16	LL	39	7111.16	0.39	lc2_4_8	12	3844.45	LL	12	3844.92	4.23
lc1_4_9	36	7452.21	SR	37	7403.24	15.64	lc2_4_9	12	4188.93	SR	12	4407.75	86.33
lc1_4_10	35	7387.13	SR	36	7223.46	37.69	lc2_4_10	12	3848.81	SAM	**12**	**3828.44**	11.49
lr1_4_1	40	10639.8	TS	40	10639.8	2.52	lr2_4_1	8	9874.37	SAM	**8**	**9726.88**	49.98
lr1_4_2	31	10057.53	SR	**31**	**10071.0**	67.79	lr2_4_2	7	9496.64	SR	8	9604.72	88.39
lr1_4_3	23	8840.46	SR	24	8658.99	72.13	lr2_4_3	6	8296.48	SR	7	8131.92	84.74
lr1_4_4	16	6744.33	SR	17	6803.99	78.70	lr2_4_4	4	6649.78	SR	5	6951.41	51.02
lr1_4_5	29	10653.77	SR	30	10480.1	34.36	lr2_4_5	7	8574.84	SR	7	9644.81	69.89
lr1_4_6	26	9695.36	SAM	**25**	**9456.68**	50.27	lr2_4_6	6	7995.06	SR	6	9327.80	80.22
lr1_4_7	19	8391.71	SR	21	7740.94	78.39	lr2_4_7	5	7304.98	SR	6	7274.63	78.76
lr1_4_8	14	5946.44	SR	15	6121.36	46.78	lr2_4_8	4	5489.06	SR	5	6138.36	87.55
lr1_4_9	24	9932.88	SR	25	9977.99	42.93	lr2_4_9	6	8043.20	SR	7	7562.21	38.74
lr1_4_10	21	8016.62	SR	22	8071.82	43.80	lr2_4_10	5	8200.90	SR	6	8095.01	28.11
lrc1_4_1	36	9174.66	SR	37	8944.58	3.63	lrc2_4_1	13	6655.52	SAM	**12**	**7652.99**	67.04
lrc1_4_2	31	8346.06	SR	32	8176.51	15.82	lrc2_4_2	11	7467.34	SAM	**11**	**6371.73**	87.76
lrc1_4_3	26	7892.26	SAM	**25**	**7307.09**	36.45	lrc2_4_3	9	5480.25	TS	9	5715.93	81.27
lrc1_4_4	19	5838.58	SR	19	5889.67	68.42	lrc2_4_4	5	5322.43	SR	6	5997.92	65.67
lrc1_4_5	33	8773.75	SR	34	8689.54	17.57	lrc2_4_5	11	6126.61	SAM	**11**	**6120.13**	38.28
lrc1_4_6	31	8177.90	SR	31	8464.16	2.22	lrc2_4_6	9	6528.11	SR	10	5928.65	75.30
lrc1_4_7	30	8113.32	SAM	**30**	**7869.45**	89.37	lrc2_4_7	8	6488.77	SR	9	5777.48	40.60
lrc1_4_8	27	7747.91	SR	28	7566.57	13.39	lrc2_4_8	7	5928.93	SR	8	6175.24	60.90
lrc1_4_9	26	8022.26	SR	27	7857.33	72.84	lrc2_4_9	7	5303.53	SR	7	5970.79	28.91
lrc1_4_10	24	7065.73	SR	25	7015.23	52.29	lrc2_4_10	6	5979.75	SR	7	5555.38	39.10

Table 4: 400 Customers

	Best			LNS				Best			LNS		
	V	TD	Pub	V	TD	Time		V	TD	Pub	V	TD	Time
lc1_6_1	60	14095.6	LL	60	14095.6	0.01	lc2_6_1	19	7977.98	SAM	19	7977.98	0.88
lc1_6_2	59	14164.0	SAM	**58**	**14379.5**	1.96	lc2_6_2	19	8253.67	SAM	19	8253.67	19.06
lc1_6_3	51	15564.11	SAM	**51**	**14569.3**	46.45	lc2_6_3	18	7461.25	SAM	**18**	**7436.50**	64.37
lc1_6_4	48	13567.5	LL	48	13750.6	89.21	lc2_6_4	18	8200.89	TS	18	9479.88	89.99
lc1_6_5	60	14086.3	LL	60	14086.3	0.82	lc2_6_5	19	8054.35	SAM	**19**	**8047.37**	53.37
lc1_6_6	60	14090.8	SAM	60	14090.8	0.51	lc2_6_6	19	8169.95	TS	19	8237.58	53.36
lc1_6_7	60	14083.8	SAM	60	14083.8	0.82	lc2_6_7	19	8205.66	TS	**19**	**8038.56**	48.81
lc1_6_8	59	14554.3	SAM	59	14554.3	11.32	lc2_6_8	18	7808.16	SAM	19	7855.38	88.57
lc1_6_9	55	14626.3	TS	55	14648.1	85.44	lc2_6_9	19	8134.25	SAM	19	8304.29	43.55
lc1_6_10	54	14627.2	TS	54	14870.3	59.96	lc2_6_10	18	7555.35	TS	18	7853.27	55.24
lr1_6_1	59	22900.84	TS	**59**	**22838.3**	53.04	lr2_6_1	12	18863.8	SAM	**12**	**18840.8**	23.63
lr1_6_2	45	21597.9	SAM	**45**	**20985.7**	55.46	lr2_6_2	11	17452.8	TS	11	22348.2	59.90
lr1_6_3	37	19904.86	SAM	**37**	**18685.9**	82.16	lr2_6_3	9	17598.7	SAM	10	16657.5	59.69
lr1_6_4	28	13945.6	TS	28	14199.9	86.05	lr2_6_4	7	11771.5	TS	7	14223.2	82.71
lr1_6_5	39	22985.6	SAM	40	22188.8	78.88	lr2_6_5	10	19347.2	SAM	10	21250.1	88.26
lr1_6_6	33	21427.8	SAM	35	20406.2	59.73	lr2_6_6	9	19889.1	SAM	9	21722.8	89.44
lr1_6_7	27	17070.5	SAM	28	16963.8	86.42	lr2_6_7	7	16854.8	SAM	**7**	**16262.0**	59.80
lr1_6_8	20	12669.9	SAM	21	12620.1	88.01	lr2_6_8	6	11653.0	TS	6	13344.1	38.08
lr1_6_9	35	20734.7	SAM	**34**	**21273.3**	88.05	lr2_6_9	9	19395.3	SAM	**9**	**18853.4**	58.22
lr1_6_10	28	19337.5	SAM	29	18373.9	59.09	lr2_6_10	7	18449.2	SAM	8	18869.2	17.08
lrc1_6_1	53	18416.7	SAM	**53**	**17930.0**	24.34	lrc2_6_1	17	13127.7	TS	**17**	**13111.6**	22.16
lrc1_6_2	45	17179.2	SAM	**45**	**16040.3**	32.52	lrc2_6_2	15	11497.4	SAM	**15**	**11463.0**	55.74
lrc1_6_3	37	15619.8	SAM	**36**	**14407.6**	54.82	lrc2_6_3	12	12037.7	TS	**11**	**15167.3**	78.21
lrc1_6_4	25	12732.6	SAM	**25**	**11308.6**	89.82	lrc2_6_4	8	14652.7	SAM	**8**	**12512.5**	89.42
lrc1_6_5	48	16831.2	TS	**47**	**16803.9**	87.75	lrc2_6_5	14	15576.8	SAM	15	12309.7	46.47
lrc1_6_6	44	18205.3	SAM	45	17126.4	89.60	lrc2_6_6	13	12655.1	SAM	14	12894.1	72.36
lrc1_6_7	39	16407.7	SAM	40	15493.5	59.15	lrc2_6_7	11	13996.7	SAM	12	13851.5	38.01
lrc1_6_8	36	15918.6	SAM	**36**	**15352.6**	58.93	lrc2_6_8	11	14572.1	SAM	12	11877.8	89.35
lrc1_6_9	36	15751.8	SAM	37	15253.7	71.08	lrc2_6_9	10	12262.5	TS	11	14810.5	56.60
lrc1_6_10	31	14304.4	SAM	33	13830.5	59.25	lrc2_6_10	9	12379.5	TS	9	12874.8	73.08

Table 5: 600 Customers

	Best			LNS				Best			LNS		
	V	TD	Pub	V	TD	Time		V	TD	Pub	V	TD	Time
lc1_8_1	80	25184.4	SAM	80	25184.4	0.01	lc2_8_1	24	11687.1	SAM	24	11687.1	0.94
lc1_8_2	79	25694.4	TS	**78**	**26056.2**	67.14	lc2_8_2	25	12584.9	TS	**25**	**12575.0**	109.13
lc1_8_3	68	25767.6	SAM	**66**	**26700.6**	117.46	lc2_8_3	25	12520.3	TS	**25**	**12500.5**	102.52
lc1_8_4	61	23958.85	TS	**61**	**23427.2**	124.67	lc2_8_4	24	13428.1	TS	25	14368.5	117.05
lc1_8_5	80	25211.2	SAM	80	25211.2	0.01	lc2_8_5	25	12332.6	TS	**25**	**12298.9**	117.43
lc1_8_6	80	25164.3	SAM	80	25164.3	1.42	lc2_8_6	25	12074.6	LL	**25**	**12064.8**	117.72
lc1_8_7	80	25158.4	SAM	80	25158.4	4.03	lc2_8_7	25	11899.2	TS	25	12208.7	116.39
lc1_8_8	79	25243.0	TS	**78**	**25427.1**	51.66	lc2_8_8	24	11724.5	TS	24	12251.8	119.76
lc1_8_9	74	26478.09	SAM	**74**	**25536.0**	106.54	lc2_8_9	24	11700.86	TS	25	12021.2	120.0
lc1_8_10	72	26364.9	TS	73	26158.3	119.81	lc2_8_10	24	12139.06	TS	25	13134.5	113.64
lr1_8_1	80	39374.4	LL	80	39652.6	61.72	lr2_8_1	16	29961.2	SAM	17	30933.1	113.69
lr1_8_2	59	37432.7	SAM	**59**	**36122.5**	118.94	lr2_8_2	13	37565.8	SAM	14	35483.4	116.95
lr1_8_3	45	32313.2	SAM	**45**	**31763.0**	119.62	lr2_8_3	11	30046.5	SAM	11	31434.1	118.03
lr1_8_4	26	23454.6	SAM	28	23227.5	117.66	lr2_8_4	8	24925.6	SAM	9	22244.1	118.77
lr1_8_5	52	39743.9	SAM	53	38439.3	119.72	lr2_8_5	12	34256.2	SAM	13	38359.3	116.96
lr1_8_6	42	35011.9	SAM	44	35149.4	119.77	lr2_8_6	10	30688.6	SAM	11	32385.3	118.15
lr1_8_7	34	28551.9	SAM	35	28292.7	119.39	lr2_8_7	9	29137.9	SAM	**9**	**28524.9**	93.49
lr1_8_8	24	21892.0	SAM	25	20327.0	119.02	lr2_8_8	7	19878.4	TS	7	20436.0	108.51
lr1_8_9	44	36550.5	SAM	44	36840.9	117.68	lr2_8_9	11	34700.3	SAM	12	34312.2	106.46
lr1_8_10	34	31443.3	SAM	35	29861.2	114.42	lr2_8_10	10	31906.2	SAM	10	32864.7	117.97
lrc1_8_1	67	33800.5	SAM	**67**	**32587.9**	52.72	lrc2_8_1	21	21486.1	LL	21	21567.2	90.27
lrc1_8_2	57	30086.7	SAM	**56**	**28843.1**	39.18	lrc2_8_2	19	19128.0	SAM	20	21424.2	106.41
lrc1_8_3	49	26918.9	SAM	**49**	**24933.9**	111.00	lrc2_8_3	17	18842.6	TS	17	19962.9	118.77
lrc1_8_4	35	21393.7	SAM	**35**	**18768.4**	116.56	lrc2_8_4	13	20461.2	SAM	**13**	**17693.9**	113.29
lrc1_8_5	60	32578.0	SAM	62	31463.5	78.45	lrc2_8_5	18	21626.6	TS	20	22885.0	103.78
lrc1_8_6	56	29972.0	SAM	58	28818.7	119.95	lrc2_8_6	16	25106.3	SAM	17	20309.7	105.17
lrc1_8_7	53	29948.5	SAM	54	28431.8	112.56	lrc2_8_7	15	23808.4	SAM	16	19521.3	91.40
lrc1_8_8	49	28160.9	SAM	50	26901.0	114.26	lrc2_8_8	13	24260.0	SAM	14	20075.2	102.67
lrc1_8_9	47	26668.9	SAM	48	25729.6	103.92	lrc2_8_9	13	21574.2	LL	**13**	**19514.0**	119.65
lrc1_8_10	43	25787.3	SAM	44	25682.3	74.47	lrc2_8_10	12	22306.1	SAM	**12**	**19865.4**	119.08

Table 6: 800 Customers

	Best			LNS				Best			LNS		
	V	TD	Pub	V	TD	Time		V	TD	Pub	V	TD	Time
lc1_10_1	100	42488.7	LL	100	42488.7	1.36	lc2_10_1	30	16879.2	TS	30	16879.2	3.24
lc1_10_2	97	43787.9	SAM	**96**	**43437.2**	63.88	lc2_10_2	32	17941.4	SAM	**32**	**17598.6**	50.41
lc1_10_3	85	42483.61	SAM	86	42707.8	113.61	lc2_10_3	30	19199.0	SAM	32	18255.6	107.13
lc1_10_4	76	39613.8	SAM	76	39655.0	119.61	lc2_10_4	30	17726.0	LL	32	20780.5	119.85
lc1_10_5	100	42477.4	SAM	100	42477.4	3.84	lc2_10_5	31	17466.4	TS	31	17553.2	111.69
lc1_10_6	101	42838.4	TS	101	42838.4	3.09	lc2_10_6	31	17352.7	TS	32	17813.7	119.32
lc1_10_7	100	42855.0	SAM	100	42855.0	9.97	lc2_10_7	32	18131.4	TS	33	18911.4	117.60
lc1_10_8	99	42797.0	TS	**99**	**42711.7**	71.84	lc2_10_8	30	17974.2	SAM	31	17718.2	118.87
lc1_10_9	94	42946.5	TS	**93**	**42899.1**	117.99	lc2_10_9	31	17769.6	LL	34	19837.7	119.95
lc1_10_10	91	42243.4	TS	92	42420.6	118.06	lc2_10_10	30	18249.9	SAM	32	18354.3	116.52
lr1_10_1	100	58590.0	SAM	**100**	**57977.0**	103.52	lr2_10_1	19	37046.4	LL	21	51914.0	113.82
lr1_10_2	80	53089.1	TS	**80**	**52530.6**	118.34	lr2_10_2	16	53500.8	SAM	18	54870.9	117.11
lr1_10_3	54	47272.6	SAM	**54**	**45688.4**	108.29	lr2_10_3	13	43414.4	SAM	14	44770.4	110.01
lr1_10_4	31	34370.4	SAM	34	32121.2	118.13	lr2_10_4	10	34556.3	SAM	**10**	**33030.7**	119.87
lr1_10_5	64	58260.7	SAM	64	60068.6	118.66	lr2_10_5	15	56010.62	SAM	16	59682.9	119.52
lr1_10_6	46	41483.3	LL	54	49585.1	119.21	lr2_10_6	13	48225.1	SAM	15	48699.6	78.15
lr1_10_7	30	31037.1	LL	42	40315.3	119.36	lr2_10_7	11	38455.3	TS	12	40000.1	114.90
lr1_10_8	30	32814.3	SAM	32	31030.0	110.61	lr2_10_8	8	34782.5	SAM	9	30231.2	109.37
lr1_10_9	47	47298.8	LL	55	51476.6	98.63	lr2_10_9	14	55587.14	SAM	16	53937.1	112.41
lr1_10_10	24	58653.0	LL	44	46713.1	119.51	lr2_10_10	12	47678.7	SAM	13	47854.6	107.65
lrc1_10_1	85	51236.2	SAM	**84**	**49315.3**	99.94	lrc2_10_1	22	28019.7	LL	24	39205.1	126.51
lrc1_10_2	62	37917.1	LL	73	45679.5	114.13	lrc2_10_2	20	21763.1	LL	24	36260.5	117.28
lrc1_10_3	47	30706.9	LL	55	36570.5	89.07	lrc2_10_3	19	20355.4	LL	19	31336.7	102.28
lrc1_10_4	42	32463.3	SAM	**41**	**28979.2**	119.15	lrc2_10_4	14	32821.2	SAM	**14**	**25836.7**	117.05
lrc1_10_5	76	52710.2	SAM	**76**	**51455.4**	119.88	lrc2_10_5	19	28931.8	LL	21	33516.4	116.45
lrc1_10_6	69	47014.6	SAM	72	44780.2	115.78	lrc2_10_6	18	34120.6	SAM	19	32979.7	118.36
lrc1_10_7	65	44010.1	SAM	66	42454.7	116.04	lrc2_10_7	18	37111.7	SAM	**18**	**31633.3**	199.85
lrc1_10_8	60	43677.3	SAM	61	41950.5	116.27							
lrc1_10_9	55	38084.0	LL	60	41096.5	96.68							
lrc1_10_10	24	31960.9	LL	54	37482.2	119.22	lrc2_10_10	13	21028.3	LL	13	33966.6	119.98

Table 7: 1000 Customers

References

[1] Li, H. and Lim, A. A Metaheuristic for the Pickup and Delivery Problem with Time Windows In *13th IEEE International Conference on Tools with Artificial Intelligence (ICTAI)*, 160–170 (2001).

[2] Unpublished Results SINTEF Applied Mathematics-Department of Optimisation, Technical Report in Progress *http://www.sintef.no/static/am/opti/projects/top/vrp/benchmarks* (2003).

[3] Unpublished Results Ropke, S. and Pisinger, D. A General Heuristic for Vehicle Routing Problems, Workign Paper Computer Science Department at the University of Copenhagen, 2003 *http://www.sintef.no/static/am/opti/projects/top/vrp/benchmarks* (2003).

[4] Unpublished Results TS TetraSoft A/S: MapBooking Algoritm for Pickup and Delivery Solutions with Time Windows and Capacity restraints. *http://www.sintef.no/static/am/opti/projects/top/vrp/benchmarks* (2003).