

An adaptive variable neighborhood search for a heterogeneous fleet vehicle routing problem with three-dimensional loading constraints

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APPENDIX A

DETAILED COMPARISON OF OUR AVNS AND BKS FOR PURE HFVRP

Table I presents the detailed results of our AVNS and compares them to the best known solutions (BKS). The columns c_{bst} , c_{avg} , $ttb(s)$ and $gap(\%)$ are the best cost, average cost, average time to find the best solution over 30 runs and the percentage gap between the best results obtained by the AVNS and the BKS ($100 \times (c_{bst}/BKS - 1)$). Almost all of the BKS are optimal except instance 20 of HFVRP-F and HFVRP-FV.

TABLE I: Comparison between AVNS and the best known solution (BKS) on pure HFVRP instances.

Id	HFVRP-V					HFVRP-F					HFVRP-FV				
	BKS	AVNS				BKS	AVNS				BKS	AVNS			
		c_{bst}	c_{avg}	$ttb(s)$	$gap(\%)$		c_{bst}	c_{avg}	$ttb(s)$	$gap(\%)$		c_{bst}	c_{avg}	$ttb(s)$	$gap(\%)$
3	623.22	623.22	623.22	1.6	0.00	961.03	961.03	961.03	12.0	0.00	1144.22	1144.22	1144.22	43.7	0.00
4	387.18	387.18	387.18	4.6	0.00	6437.33	6437.33	6437.33	4.8	0.00	6437.33	6437.33	6437.33	1.6	0.00
5	742.87	742.87	742.87	6.6	0.00	1007.05	1007.05	1007.05	180.7	0.00	1322.26	1322.26	1322.26	22.0	0.00
6	415.03	415.03	415.03	0.3	0.00	6516.47	6516.47	6516.47	1.3	0.00	6516.47	6516.47	6516.47	1.0	0.00
13	1491.86	1491.86	1499.10	1201.4	0.00	2406.36	2406.36	2417.65	2337.7	0.00	2964.65	2964.65	2964.65	591.3	0.00
14	603.21	603.21	603.21	51.2	0.00	9119.03	9119.03	9119.04	640.1	0.00	9126.90	9126.90	9126.90	735.0	0.00
15	999.82	999.82	1000.30	1297.4	0.00	2586.37	2586.37	2586.43	1153.3	0.00	2634.96	2634.96	2635.05	1089.3	0.00
16	1131.00	1131.00	1131.00	368.7	0.00	2720.43	2721.80	2753.23	2126.4	0.05	3168.92	3168.92	3170.09	1266.8	0.00
17	1038.60	1038.60	1040.58	1567.1	0.00	1734.53	1745.32	1751.24	2191.5	0.62	2004.48	2004.48	2020.00	1951.0	0.00
18	1800.80	1801.40	1817.87	2227.6	0.03	2369.65	2373.63	2383.84	2325.3	0.17	3147.99	3153.09	3157.84	2177.3	0.16
19	1105.44	1105.44	1108.36	1736.2	0.00	8661.81	8663.54	8666.24	1968.2	0.02	8661.81	8662.86	8665.63	1579.7	0.01
20	1530.43	1532.66	1536.44	2256.1	0.15	<i>4037.90</i>	4046.04	4079.47	2342.2	0.20	<i>4153.02</i>	4157.06	4172.26	1388.0	0.10
Avg	989.12	989.36	992.10	893.2	0.01	4046.50	4048.66	4056.58	1273.6	0.09	4273.58	4274.43	4277.73	903.9	0.02

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APPENDIX B

DETAILED RESULTS FOR THE 3L-CVRP

Table II summarizes the computational environments of the existing algorithms for solving the 3L-CVRP.

TABLE II: Computational environments

Algorithm	CPU	RAM	Running Times
TS	Pentium IV 3 GHz	512 MB	1
GTS	Pentium IV 2.8GHz	1 GB	1
ACO	Pentium IV 3.2GHz	2 GB	10
DMTS	Xeon E5520 2.26GHz	8 GB	10
VRLH1	Intel 3.17 GHz PC(Core2 Duo E8500)	2 GB	10
HA	Pentium IV 2.3 GHz	1 GB	1
AVNS	Intel Xeon E5430 with a 2.66 GHz (Quad Core) CPU	8 GB	30

Table III gives the comparison of the average cost on the two set of instances found by the existing approaches and the AVNS, where the minimum average cost is marked as bold. Note that as some of the final solutions (the instances 9 and 12 in set 2) found by the AVNS use more vehicles than the limit, we exclude the instances 9 and 12 while reporting the results for set 2. From this table, we can see that our approach outperforms all existing approaches on all test versions.

TABLE III: Comparison of the average cost between AVNS and existing approaches on 3L-CVRP instances set (Set 2 excluding instance 9 and 12).

Set	Constraints	TS	GTS	ACO	DMTS	VRLH1	HA	AVNS
1	All Constraints	1042.26	997.18	966.67	962.08	953.79	960.10	942.12
1	No fragility	1014.49	965.14	945.04	941.08	934.38	935.92	920.00
1	No support	939.53	934.96	919.69	913.43	902.55	903.18	892.04
1	No LIFO	951.19	950.59	916.25	887.71	912.05	912.47	874.32
1	Loading only	876.31	876.39	856.66	846.44	864.54	858.07	842.13
2	All Constraints	-	2951.96	-	2883.81	2895.63	-	2800.13
2	No fragility	-	2915.83	-	-	2850.90	-	2768.56
2	No support	-	2837.74	-	-	2792.34	-	2731.77
2	No LIFO	-	2807.83	-	-	2799.87	-	2694.24
2	Loading only	-	2737.35	-	-	2729.87	-	2649.49

Table IV and V compare the average cost of each instance in the set 1 and 2 of 3L-CVRP respectively, where the best solution is marked as bold. The column c_{avg} is the average cost of each instance found by the approach and $t_{bb}(s)$ gives the average time to find the best solution. The column BKS gives the best of c_{avg} found by TS, GTS, AzCO, DMTS, VRLH1 and HA. For the AVNS, we also report the gap $gap(\%)$ between the cost obtained by the AVNS to the BKS. For any instance, assume the best c_{avg} is c_{best} and the average cost found by the AVNS

is c_{avns} , then $gap(\%)$ is defined as $100 \times (c_{avns}/c_{best} - 1)$. Due to the space limit, we only report the detailed results of some selected approaches with excellent performance. Noted that the results obtained by the AVNS for instances 9 and 12 in set 2 use more vehicles than the limit, we exclude instances 9 and 12 when reporting the results. From these two tables, we can see that the AVNS could find better c_{avg} for 16 out of 27 instances in set 1 and all 10 instances in set 2.

TABLE IV: Comparison between AVNS and existing approaches on each 3L-CVRP set 1 instances.

Id	Name	DMTS		VRLHI		HA		BKS	AVNS		
		c_{avg}	$ttb(s)$	c_{avg}	$ttb(s)$	c_{avg}	$ttb(s)$	c_{avg}	c_{avg}	$ttb(s)$	gap(%)
1	E016-03m	302.23	85.1	302.02	72.3	303.21	98.9	302.02	302.02	66.3	0.00
2	E016-05m	334.96	3.5	334.96	0.9	334.96	4.6	334.96	334.96	0.2	0.00
3	E021-04m	409.44	450.1	401.44	182.0	398.05	93.9	398.05	387.84	156.8	-2.57
4	E021-06m	439.98	51.2	437.54	16.1	440.68	46.8	437.54	437.19	27.3	-0.08
5	E022-04g	447.36	287.8	451.03	182.6	452.56	64.0	447.36	447.58	425.8	0.05
6	E022-06m	499.99	130.6	498.38	23.6	498.56	196.9	498.38	501.20	7.4	0.57
7	E023-03g	773.31	421.0	772.49	133.1	790.23	317.0	772.49	771.02	66.8	-0.19
8	E023-05s	807.59	548.2	821.35	139.1	820.67	98.9	807.59	808.55	199.3	0.12
9	E026-08m	630.13	95.5	645.81	24.3	635.5	353.1	630.13	630.73	1.9	0.10
10	E030-03g	839.75	601.5	827.29	175.1	836.21	410.9	827.29	828.60	979.1	0.16
11	E030-04s	790.47	434.4	815.62	136.4	825.75	197.8	790.47	776.25	614.0	-1.80
12	E031-09h	615.05	224.8	630.46	14.0	626.59	89.5	615.05	610.23	28.7	-0.78
13	E033-03n	2732.85	654.6	2694.81	268.4	2739.8	319.8	2694.81	2703.62	843.3	0.33
14	E033-04g	1460.34	2659.3	1413.59	311.6	1469.38	268.4	1413.59	1436.25	962.7	1.60
15	E033-05s	1386.75	984.6	1355.5	311.5	1369.69	356.6	1355.5	1351.38	1062.5	-0.30
16	E036-11h	698.69	50.2	705.05	3.4	703.15	431.7	698.61	698.61	4.0	-0.00
17	E041-14h	869.96	177.2	917.96	2.5	872.05	374.8	869.96	866.40	167.0	-0.41
18	E045-04f	1252.67	2258.6	1228.98	309.5	1250.86	325.7	1228.98	1240.87	1290.2	0.97
19	E051-05e	777.96	1407.2	753.87	416.5	780.37	1374.8	753.87	750.17	2138.0	-0.49
20	E072-04f	600.82	7466.0	596.42	427.0	605.59	1337.0	596.42	579.50	2324.3	-2.84
21	E076-07s	1140.11	2848.6	1107	443.4	1119.45	1247.9	1107	1086.26	2581.0	-1.87
22	E076-08s	1199.14	1890.0	1171.49	423.5	1167.28	1294.6	1167.28	1164.65	2196.9	-0.22
23	E076-10e	1176.07	2829.5	1135.46	425.8	1171.77	1105.7	1135.46	1117.77	2163.8	-1.56
24	E076-14s	1161.87	2391.6	1128.82	411.1	1136.27	2001.1	1128.82	1116.34	2053.1	-1.11
25	E101-08e	1442.62	3580.3	1428.8	453.0	1426.34	1458.8	1426.34	1391.74	2333.5	-2.43
26	E101-10c	1614.56	2968.7	1625.31	430.6	1585.46	3354.7	1585.46	1584.44	2619.0	-0.06
27	E101-14s	1571.38	2837.8	1550.85	435.0	1562.18	3140.2	1550.85	1512.92	2231.9	-2.45
Avg		962.08	1419.9	953.79	228.6	960.10	754.2	947.20	942.12	1020.2	-0.57

Table VI and VII give the detailed results found by the AVNS on each instance in the set 1 and 2 of 3L-CVRP respectively, where the column c_{bst} , c_{avg} and $ttb(s)$ is the best cost, average cost and average time to find the best solution for each instance.

TABLE V: Comparison between AVNS and existing approaches on 3L-CVRP set 2 instances excluding 9 and 12.

Id	Name	GTS		DMTS		VRLHI		BKS	AVNS		
		c_{avg}	$ttb(s)$	c_{avg}	$ttb(s)$	c_{avg}	$ttb(s)$	c_{avg}	c_{avg}	$ttb(s)$	gap(%)
1	50-1	1457.78	1387.6	1451.14	1404.4	1456.30	407.7	1451.14	1417.88	384.8	-2.29
2	50-2	2257.60	975.8	2222.50	390.0	2225.20	113.6	2222.50	2196.95	1464.6	-1.15
3	50-3	1838.40	1065.8	1817.52	3356.8	1821.90	416.6	1817.52	1730.25	2038.6	-4.80
4	75-1	2059.32	2286.0	2078.00	2565.0	2067.47	415.8	2059.32	2013.00	2196.4	-2.25
5	75-2	3279.16	1460.1	3166.69	858.2	3078.92	334.5	3078.92	3006.27	1876.3	-2.36
6	75-3	2508.17	1768.3	2540.58	5019.7	2534.36	415.5	2508.17	2376.77	2180.6	-5.24
7	100-1	2690.23	4895.5	2613.04	7448.5	2645.02	469.3	2613.04	2509.44	1919.5	-3.96
8	100-2	4342.64	3281.8	4237.80	835.3	4269.22	207.3	4237.80	4200.80	1636.0	-0.87
10	125-1	3298.22	6850.2	3260.23	8416.3	3294.00	441.7	3260.23	3176.37	1873.7	-2.57
11	125-2	5788.12	5281.7	5450.58	1854.6	5563.91	320.3	5450.58	5373.55	1158.6	-1.41
Avg		2951.96	2925.3	2883.81	3214.9	2895.63	354.2	2869.92	2800.13	1672.9	-2.69

TABLE VI: Detailed results of AVNS on 3L-CVRP set 1 instances.

Id	Name	All Constraints			No fragility			No support			No LIFO			Loading only		
		c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$
1	E016-03m	302.02	302.02	66.3	301.74	301.74	5.1	298.70	298.70	12.8	297.65	298.28	2.5	297.65	297.65	1.3
2	E016-05m	334.96	334.96	0.2	334.96	334.96	0.1	334.96	334.96	0.1	334.96	334.96	0.1	334.96	334.96	0.1
3	E021-04m	385.53	387.84	156.8	379.57	379.57	74.2	362.27	366.90	350.9	362.27	362.27	10.7	362.27	362.27	2.8
4	E021-06m	437.19	437.19	27.3	437.19	437.19	7.2	430.89	430.89	0.9	430.89	430.89	0.8	430.89	430.89	0.5
5	E022-04g	447.04	447.58	425.8	439.65	439.65	153.3	427.56	427.56	241.5	406.50	406.50	53.6	379.43	395.26	7.4
6	E022-06m	501.06	501.20	7.4	495.85	495.85	3.7	495.85	495.85	1.9	495.85	495.85	0.6	495.85	495.85	0.3
7	E023-03g	769.68	771.02	66.8	769.68	769.68	30.9	750.38	751.74	279.1	732.52	732.52	16.1	715.02	729.10	12.0
8	E023-05s	808.55	808.55	199.3	804.97	806.16	370.8	785.58	797.54	223.7	735.14	735.14	78.4	730.66	731.26	348.8
9	E026-08m	630.13	630.73	1.9	630.13	630.56	1.2	630.13	630.19	1.2	630.13	630.13	1.2	630.13	630.13	1.4
10	E030-03g	826.41	828.60	979.1	785.08	796.67	1160.2	748.36	749.46	935.4	746.62	747.79	1201.7	697.53	706.28	534.8
11	E030-04s	776.19	776.25	614.0	754.66	772.84	601.8	733.46	734.01	841.5	718.25	718.25	52.5	718.25	718.25	11.5
12	E031-09h	610.23	610.23	28.7	610.23	610.23	34.0	610.23	610.23	18.2	610.00	610.00	32.8	610.00	610.00	21.2
13	E033-03n	2680.54	2703.62	843.3	2614.79	2626.98	1115.3	2465.41	2465.41	398.1	2439.71	2449.74	354.4	2306.04	2311.18	474.4
14	E033-04g	1386.65	1436.25	962.7	1347.44	1354.50	999.5	1313.23	1326.89	1353.8	1283.07	1305.84	1296.8	1184.44	1188.41	971.3
15	E033-05s	1338.32	1351.38	1062.5	1326.38	1334.03	1083.7	1239.78	1299.33	1256.3	1183.67	1205.71	1221.3	1149.92	1164.89	886.7
16	E036-11h	698.61	698.61	4.0	698.61	698.61	3.8	698.61	698.61	3.9	698.61	698.61	3.3	698.61	698.61	2.5
17	E041-14h	866.40	866.40	167.0	866.40	866.40	258.4	863.27	864.73	173.9	866.40	866.40	155.2	861.79	861.79	91.5
18	E045-04f	1227.09	1240.87	1290.2	1162.33	1181.76	1199.7	1137.25	1157.18	1351.8	1129.44	1139.88	1211.8	1094.58	1105.74	1021.6
19	E051-05e	746.16	750.17	2138.0	729.10	731.81	1614.5	697.86	703.86	2080.2	677.52	679.43	2075.6	656.05	660.06	1978.0
20	E072-04f	576.88	579.50	2324.3	558.93	561.33	1910.0	550.52	551.99	2431.0	539.39	543.79	2344.2	503.22	504.31	1795.5
21	E076-07s	1067.70	1086.26	2581.0	1042.05	1053.51	2553.5	992.88	1007.01	2191.8	967.86	977.55	2480.8	926.90	933.75	2553.0
22	E076-08s	1159.60	1164.65	2196.9	1123.03	1132.26	1995.1	1077.19	1086.64	2567.0	1060.41	1068.67	2774.2	1003.27	1007.47	1916.0
23	E076-10e	1103.44	1117.77	2163.8	1084.44	1094.23	2222.0	1032.51	1041.21	2289.0	1012.03	1021.16	2584.6	959.26	964.55	2322.6
24	E076-14s	1102.14	1116.34	2053.1	1084.43	1087.26	1897.0	1059.85	1064.64	2158.0	1050.01	1055.01	1853.1	1035.80	1038.53	1903.1
25	E101-08e	1370.34	1391.74	2333.5	1325.83	1346.17	2586.7	1268.73	1287.01	2720.7	1242.53	1262.65	2349.1	1165.62	1187.51	2286.1
26	E101-10e	1557.15	1584.44	2619.0	1496.46	1524.06	2920.3	1482.39	1496.91	2323.9	1453.95	1466.38	2567.2	1357.26	1371.72	2348.7
27	E101-14s	1496.28	1512.92	2231.9	1461.58	1472.07	1965.8	1392.15	1405.60	2256.4	1350.75	1363.24	2565.2	1290.08	1297.08	1867.8
Avg		933.57	942.12	1020.2	913.54	920.00	991.4	884.44	892.04	1054.2	868.74	874.32	1010.7	836.87	842.13	865.2

TABLE VII: Detailed results of AVNS on 3L-CVRP set 2 instances excluding 9 and 12.

Id	Name	All Constraints			No fragility			No support			No LIFO			Loading only		
		c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$	c_{bst}	c_{avg}	$ttb(s)$
1	50-1	1417.88	1417.88	384.8	1417.88	1417.88	86.9	1417.88	1417.88	74.1	1417.88	1417.88	22.2	1417.88	1417.88	9.2
2	50-2	2189.27	2196.95	1464.6	2156.75	2161.41	1132.9	2135.97	2139.40	1222.1	2105.21	2105.21	31.9	2072.57	2072.57	174.5
3	50-3	1713.82	1730.25	2038.6	1661.75	1674.62	2044.7	1569.77	1581.33	2181.2	1578.06	1592.23	2199.7	1512.97	1521.51	90.0
4	75-1	2010.58	2013.00	2196.4	2004.66	2009.33	1897.9	2003.57	2007.39	1828.6	2003.57	2003.57	101.8	2003.57	2003.57	62.0
5	75-2	2971.58	3006.27	1876.3	2912.81	2943.99	1761.1	2924.07	2948.05	1490.3	2836.60	2851.96	1741.4	2738.67	2740.13	1465.1
6	75-3	2339.30	2376.77	2180.6	2305.10	2341.86	2233.3	2265.05	2270.21	1852.0	2249.36	2260.31	1773.4	2195.84	2198.60	1474.9
7	100-1	2492.10	2509.44	1919.5	2438.39	2468.82	1796.5	2442.08	2464.84	1560.2	2430.79	2438.79	1226.0	2423.29	2425.06	1325.4
8	100-2	4163.02	4200.80	1636.0	4123.43	4161.81	1417.7	4059.29	4072.83	1390.1	4022.43	4035.65	1051.7	3958.09	3992.37	1620.2
10	125-1	3159.15	3176.37	1873.7	3154.33	3161.03	1338.3	3155.44	3159.98	1507.8	3147.50	3152.68	1226.5	3147.50	3151.38	1222.1
11	125-2	5315.97	5373.55	1158.6	5278.57	5344.85	1037.8	5206.01	5255.79	1045.5	5042.51	5084.09	1567.2	4936.37	4971.84	1351.5
Avg		2777.27	2800.13	1672.9	2745.37	2768.56	1474.7	2717.91	2731.77	1415.2	2683.39	2694.24	1094.2	2640.68	2649.49	879.5

TABLE VIII: Comparison of the average cost between AVNS and VRLH1 with the same runtime on 3L-CVRP instances (Set 2 excluding instances 9 and 12).

Constraints	Set 1		Set 2	
	VRLH1	AVNS	VRLH1	AVNS
All constraints	953.79	953.05	2895.63	2833.57
No fragility	934.38	930.12	2850.90	2790.63
No support	902.55	901.03	2792.34	2754.08
No LIFO	912.05	883.94	2799.87	2708.24
Loading only	864.54	846.55	2729.87	2659.67

APPENDIX C

COMPARISON ON 3L-CVRP USING SHORT RUNNING TIME

To further evaluate the effectiveness of the AVNS, we perform our AVNS using the same runtime of the VRLH1. The comparisons of the average cost on the two data sets are summarized in Table VIII. Our AVNS gets slightly better results for three versions on set 1. Obviously, the AVNS obtains much better solutions than the VRLH1 for two versions (No LIFO and Loading only) on set 1 and all versions on set 2. Thus, it is convinced that the proposed AVNS is superior than the VRLH1. All results demonstrate that our AVNS not only can obtain better solutions than other algorithms within short time, but also can continue to improve the solutions if more time is given. This characteristic is very helpful for different decision makers that they can set the runtime according to their needs.

APPENDIX D

DETAILED RESULTS FOR 3L-HFVRP

Table IX provides the detailed results for the various 3L-HFVRP versions with different constraints, where the best cost c_{bst} , average cost c_{avg} and the average time to find the best cost $ttb(s)$ over 30 runs is reported.

TABLE IX: Detailed results of AVNS on 3L-HFVRP instances.

Inst.	All constraints			No fragility			No LIFO			No support			Loading only		
	c_{bat}	c_{avg}	$ttb(s)$	c_{bat}	c_{avg}	$ttb(s)$	c_{bat}	c_{avg}	$ttb(s)$	c_{bat}	c_{avg}	$ttb(s)$	c_{bat}	c_{avg}	$ttb(s)$
1	632.12	632.12	3.6	627.73	627.73	5.4	624.84	624.84	24.0	624.84	624.84	3.6	624.84	624.84	3.8
2	961.03	961.03	98.7	961.03	961.03	28.9	961.03	961.03	27.3	961.03	961.03	34.1	961.03	961.03	16.1
3	1157.52	1157.52	14.3	1157.52	1157.52	25.4	1157.52	1157.52	29.1	1144.22	1144.22	22.9	1144.22	1144.22	30.1
4	411.06	411.17	381.5	406.16	406.16	49.4	393.09	393.09	30.1	393.09	393.09	124.8	390.60	390.60	5.4
5	8926.38	9303.06	514.5	8332.90	8579.75	591.2	7320.80	7750.18	531.0	7814.48	8268.57	549.3	7313.64	7314.61	422.1
6	7920.70	8091.76	456.9	7911.52	7925.16	536.2	7441.75	7466.72	533.1	7891.21	7905.00	502.7	7421.29	7421.29	56.2
7	746.34	746.34	35.9	746.34	746.34	24.2	746.34	746.34	23.0	746.34	746.34	24.4	746.34	746.34	19.2
8	1007.05	1009.23	431.2	1007.05	1007.65	414.2	1007.05	1007.26	235.6	1007.05	1007.26	426.8	1007.05	1007.10	216.0
9	1322.26	1322.26	13.6	1322.26	1322.26	8.8	1322.26	1322.26	8.2	1322.26	1322.26	10.8	1322.26	1322.26	9.2
10	416.01	417.64	461.4	415.03	415.03	144.5	415.03	415.03	4.7	415.03	415.03	34.4	415.03	415.03	3.8
11	7811.98	7895.78	600.1	7371.72	7801.77	404.7	7324.03	7330.15	430.2	7407.33	7784.52	387.3	7324.03	7324.03	83.4
12	7430.57	7437.48	486.3	7422.20	7422.66	243.2	7069.69	7388.30	89.1	7422.20	7422.20	29.6	7027.50	7029.44	396.4
13	1493.37	1499.84	1671.5	1491.86	1498.49	1631.2	1491.86	1497.55	1330.4	1491.86	1497.79	1406.0	1491.86	1499.75	1378.4
14	2437.15	2480.95	2242.6	2434.22	2463.74	2735.2	2423.56	2448.94	2038.8	2433.74	2454.26	2337.6	2418.63	2435.18	2040.6
15	3041.96	3043.56	1826.9	3025.59	3025.59	619.0	3020.78	3021.06	1547.9	3014.20	3014.20	1052.0	3014.13	3014.13	740.2
16	750.91	760.02	2314.1	729.68	736.97	1811.3	677.54	684.91	2169.3	694.48	709.87	2400.6	661.67	661.71	1078.6
17	15872.10	16244.35	2851.8	15453.20	16006.99	2819.0	14964.80	15407.73	2689.5	15344.10	15596.24	2863.8	14254.30	14478.26	2680.6
18	15597.00	16648.87	2698.6	15098.70	15931.31	2330.6	15461.90	16209.12	2750.4	14591.00	15478.41	2374.9	14042.70	14842.47	2000.2
19	1083.37	1099.12	2605.4	1065.42	1080.79	2008.0	1034.26	1041.95	2173.3	1054.64	1062.64	2311.0	1030.25	1030.35	1517.1
20	3303.69	3444.30	2484.7	3245.50	3354.41	2855.2	2974.09	3080.06	2728.0	3152.04	3237.40	2905.6	2826.53	2882.63	2520.2
21	3101.04	3173.54	2301.2	3069.86	3122.77	2450.1	2985.41	3042.93	2137.1	3025.90	3076.63	2642.3	2948.71	2978.02	1865.4
22	1205.00	1217.69	2197.0	1194.39	1208.27	2238.6	1158.44	1159.84	2169.9	1165.78	1178.08	1845.9	1154.17	1156.06	1925.3
23	3132.19	3225.12	3219.9	3016.52	3093.78	2777.9	2875.22	2942.03	2913.2	2944.78	3017.11	2557.9	2794.84	2850.09	2305.9
24	3450.62	3519.82	2323.8	3368.25	3461.61	1895.4	3279.98	3322.94	2250.1	3266.38	3324.16	2192.9	3189.63	3219.37	1707.7
25	1296.77	1329.13	3060.7	1264.31	1289.77	3159.4	1182.68	1203.85	2842.1	1219.64	1240.90	2882.0	1129.89	1150.86	2587.8
26	2725.30	2787.71	2716.9	2676.07	2741.29	2880.1	2520.11	2584.37	2648.3	2598.39	2637.04	2857.7	2380.37	2425.00	2892.7
27	2549.44	2569.17	2650.8	2472.46	2492.60	2434.0	2358.61	2396.59	2952.6	2386.03	2413.10	2703.6	2225.11	2258.76	2770.2
28	2331.10	2404.83	3053.0	2269.13	2338.86	2880.2	2187.99	2238.00	3030.7	2220.94	2260.78	2988.1	2072.62	2106.28	2770.6
29	2788.15	2840.43	2751.7	2737.71	2781.47	2939.6	2607.90	2639.36	2950.4	2605.59	2652.07	2821.1	2519.68	2548.18	2643.7
30	3290.95	3303.13	1704.9	3258.32	3270.02	2065.4	3252.35	3271.14	1744.6	3233.94	3249.09	1838.1	3232.87	3245.05	1893.8
31	1758.25	1805.62	3446.6	1684.70	1740.70	3428.9	1529.27	1564.97	3334.9	1618.85	1651.88	3432.9	1448.05	1486.78	3168.6
32	15960.70	16330.91	2810.5	15322.00	15850.47	2832.4	14625.50	15147.30	3190.0	14669.60	15073.85	3012.9	13329.90	13753.64	2740.1
33	30273.30	30969.79	3487.3	29481.00	30296.17	3676.4	27872.10	28679.35	4220.5	28734.60	29377.87	3707.4	26259.70	27106.37	4229.5
34	2111.50	2161.34	3187.4	2045.51	2100.93	3274.0	1926.11	1978.46	3384.8	1990.76	2028.42	3186.5	1835.72	1878.80	3220.0
35	6177.48	6273.22	3288.4	5954.90	6091.82	2886.6	5645.45	5747.98	3113.3	5661.60	5770.90	3177.1	5248.06	5373.23	2927.6
36	8206.78	8447.19	3828.8	7820.46	8170.64	3853.1	7518.45	7860.50	3815.1	7737.79	8019.36	3775.5	6587.80	7220.71	3470.2
Avg	4796.70	4915.70	1895.1	4662.81	4792.29	1804.4	4482.16	4603.71	1835.9	4555.71	4667.12	1817.3	4272.08	4369.51	1620.5
gap(%)				-2.79	-2.51		-6.56	-6.35		-5.02	-5.06		-10.94	-8.91	