

Supplementary material for Liu L, Li K, and Liu Z, A capacitated vehicle routing problem with order available time in e-commerce industry, *Engineering Optimization*, 2016

**Table 1. Computational results of four algorithms for CVRPOAT (A)**

CASE	GTS		GA		LB_LR	LB_CVRP	GAP1	GAP2	GAP3
	Z1	T1 (s)	Z2	T2 (s)	LB1	LB2	$(Z2-Z1)/Z2 \times 100\%$	$(Z1-LB1)/Z1 \times 100\%$	$(LB1-LB2)/LB1 \times 100\%$
A-n32-k5	1233	3	1242	8.0	1162	1141	0.72%	5.76%	1.84%
A-n33-k5	862	3	887	8.0	845	825	2.82%	1.97%	2.42%
A-n33-k6	1344	3	1367	8.0	1314	1252	1.68%	2.23%	4.95%
A-n34-k5	1202	3	1237	9.0	1163	1125	2.83%	3.24%	3.38%
A-n36-k5	1220	3	1257	9.0	1161	1133	2.94%	4.84%	2.47%
A-n37-k5	1017	3	1037	10.0	977	941	1.93%	3.93%	3.83%
A-n37-k6	1359	3	1396	10.0	1341	1286	2.65%	1.32%	4.28%
A-n38-k5	1226	3	1252	10.0	1212	1140	2.08%	1.14%	6.32%
A-n39-k5	1334	4	1356	10.0	1305	1227	1.62%	2.17%	6.36%
A-n39-k6	1329	4	1340	10.0	1270	1235	0.82%	4.44%	2.83%
A-n44-k6	1485	5	1521	11.0	1407	1369	2.37%	5.25%	2.78%
A-n45-k6	1592	5	1652	11.0	1519	1467	3.63%	4.59%	3.54%
A-n45-k7	1666	5	1692	13.0	1582	1555	1.54%	5.04%	1.74%
A-n46-k7	1478	5	1552	13.0	1411	1356	4.77%	4.53%	4.06%
A-n48-k7	1657	5	1687	14.0	1570	1517	1.78%	5.25%	3.49%
A-n53-k7	1688	7	1720	16.0	1593	1529	1.86%	5.63%	4.19%
A-n54-k7	1868	7	1932	17.0	1738	1744	3.31%	6.96%	-0.34%
A-n55-k9	1699	7	1748	17.0	1589	1573	2.80%	6.47%	1.02%
A-n60-k9	2103	9	2119	20.0	1923	1948	0.76%	8.56%	-1.28%
A-n61-k9	1776	10	1818	20.0	1609	1583	2.31%	9.40%	1.64%
A-n62-k8	2111	9	2123	20.0	1901	1913	0.57%	9.95%	-0.63%
A-n63-k9	2477	10	2532	22.0	2230	2244	2.17%	9.97%	-0.62%
A-n63-k10	2082	10	2071	21.0	1885	1896	-0.53%	9.46%	-0.58%
A-n64-k9	2145	10	2187	22.0	1965	1961	1.92%	8.39%	0.20%
A-n65-k9	1986	10	2001	22.0	1814	1793	0.75%	8.66%	1.17%
A-n69-k9	2067	12	2108	25.0	1883	1863	1.94%	8.90%	1.07%
A-n80-k10	2781	20	2943	30.0	2510	2530	5.50%	9.74%	-0.79%
Average	1659	7	1695	15	1551	1524	2.13%	5.85%	2.20%

**Table 2. Computational results of four algorithms for CVRPOAT (B)**

CASE	GTS		GA		LB_LR	LB_CVRP	GAP1	GAP2	GAP3
	Z1	T1 (s)	Z2	T2 (s)	LB1	LB2	$(Z2-Z1)/Z2 \times 100\%$	$(Z1-LB1)/Z1 \times 100\%$	$(LB1-LB2)/LB1 \times 100\%$
B-n31-k5	914	3	913	7	832	877	-0.11%	8.97%	-5.13%
B-n34-k5	1131	3	1135	8	1078	1083	0.35%	4.69%	-0.46%
B-n35-k5	1492	3	1512	9	1345	1394	1.32%	9.85%	-3.52%
B-n38-k6	1205	3	1209	10	1098	1131	0.33%	8.88%	-2.92%
B-n39-k5	917	4	959	10	878	852	4.38%	4.25%	3.05%
B-n41-k6	1322	4	1335	11	1291	1218	0.97%	2.34%	5.99%
B-n43-k6	1153	5	1159	12	1091	1067	0.52%	5.38%	2.25%
B-n44-k7	1383	5	1414	12	1290	1283	2.19%	6.72%	0.55%
B-n45-k5	1377	6	1388	12	1331	1237	0.79%	3.34%	7.60%
B-n45-k6	1084	7	1086	13	1036	1000	0.18%	4.43%	3.60%
B-n50-k7	1353	6	1365	15	1243	1229	0.88%	8.13%	1.14%
B-n50-k8	1843	8	1856	15	1716	1742	0.70%	6.89%	-1.49%
B-n51-k7	1621	7	1666	15	1561	1518	2.70%	3.70%	2.83%
B-n52-k7	1400	10	1409	15	1278	1275	0.64%	8.71%	0.24%
B-n56-k7	1318	9	1354	18	1206	1183	2.66%	8.50%	1.94%
B-n57-k7	2143	10	2146	18	1914	1808	0.14%	10.69%	5.86%
B-n57-k9	2247	9	2268	21	1973	2087	0.93%	12.19%	-5.46%
B-n63-k10	2340	9	2329	24	2043	2128	-0.47%	12.69%	-3.99%
B-n64-k9	1511	9	1522	28	1368	1370	0.72%	9.46%	-0.15%
B-n66-k9	1971	9	1978	29	1790	1840	0.35%	9.18%	-2.72%
B-n67-k10	1822	12	1830	29	1586	1612	0.44%	12.95%	-1.61%
B-n68-k9	2154	15	2206	23	1918	1969	2.36%	10.96%	-2.59%
B-n78-k10	2193	16	2246	36	1984	1987	2.36%	9.53%	-0.15%
Average	1561	8	1578	17	1428	1430	1.10%	7.93%	0.21%

**Table 3. Computational results of four algorithms for CVRPOAT (P)**

CASE	GTS		GA		LB_LR	LB_CVRP	GAP1	GAP2	GAP3
	Z1	T1 (s)	Z2	T2 (s)	LB1	LB2	$(Z2-Z1)/Z2 \times 100\%$	$(Z1-LB1)/Z1 \times 100\%$	$(LB1-LB2)/LB1 \times 100\%$
P-n16-k8	508	1	520	4	504	502	2.31%	0.79%	0.40%
P-n19-k2	325	1	346	4	321	309	6.07%	1.23%	3.88%
P-n20-k2	323	2	324	4	322	315	0.31%	0.31%	2.22%
P-n21-k2	321	2	330	5	320	301	2.73%	0.31%	6.31%
P-n22-k2	328	2	335	5	327	314	2.09%	0.30%	4.14%
P-n22-k8	688	2	703	5	686	681	2.13%	0.29%	0.73%
P-n23-k8	638	2	630	5	630	609	-1.27%	1.25%	3.45%
P-n40-k5	699	3	716	11	675	650	2.37%	3.43%	3.85%
P-n45-k5	795	5	816	13	779	744	2.57%	2.01%	4.70%
P-n50-k7	825	6	857	15	780	769	3.73%	5.45%	1.43%
P-n50-k8	944	8	975	15	868	854	3.18%	8.05%	1.64%
P-n50-k10	978	7	1001	15	895	916	2.30%	8.49%	-2.29%
P-n51-k10	1046	8	1047	16	970	968	0.10%	7.27%	0.21%
P-n55-k7	869	8	893	17	812	805	2.69%	6.56%	0.87%
P-n55-k10	1015	8	1025	21	902	933	0.98%	11.13%	-3.32%
P-n60-k10	1143	11	1152	19	1019	1053	0.78%	10.85%	-3.23%
P-n60-k15	1338	12	1369	20	1206	1240	2.26%	9.87%	-2.74%
P-n65-k10	1203	15	1240	22	1077	1100	2.98%	10.47%	-2.09%
P-n70-k10	1320	23	1336	24	1156	1176	1.20%	12.42%	-1.70%
P-n76-k4	1106	23	1109	27	1035	984	0.27%	6.42%	5.18%
P-n76-k5	1116	27	1140	27	1000	997	2.11%	10.39%	0.30%
P-n101-k4	1241	35	1222	45	---	1084	-1.55%	---	---
Average	853	10	868	15	775	787	1.83%	5.59%	1.14%

**Table 4. Computational results of the operation method for CVRPOAT (A, B, P)**

Case	Result	GAP	Case	Result	GAP	Case	Result	GAP
A-n32-k5	1656	34.31%	A-n65-k9	3010	51.56%	B-n68-k9	3024	40.39%
A-n33-k5	1264	46.64%	A-n69-k9	3057	47.90%	B-n78-k10	3246	48.02%
A-n33-k6	1767	31.47%	A-n80-k10	4203	51.13%	P-n16-k8	587	15.55%
A-n34-k5	1624	35.11%	B-n31-k5	1152	26.04%	P-n19-k2	362	11.38%
A-n36-k5	1605	31.56%	B-n34-k5	1788	58.09%	P-n20-k2	363	12.38%
A-n37-k5	1556	53.00%	B-n35-k5	1857	24.46%	P-n21-k2	374	16.51%
A-n37-k6	1810	33.19%	B-n38-k6	1682	39.59%	P-n22-k2	369	12.50%
A-n38-k5	1719	40.21%	B-n39-k5	1602	74.70%	P-n22-k8	928	34.88%
A-n39-k5	1690	26.69%	B-n41-k6	1854	40.24%	P-n23-k8	699	9.56%
A-n39-k6	1879	41.38%	B-n43-k6	1574	36.51%	P-n40-k5	983	40.63%
A-n44-k6	1960	31.99%	B-n44-k7	1877	35.72%	P-n45-k5	1177	48.05%
A-n45-k6	2286	43.59%	B-n45-k5	1895	37.62%	P-n50-k7	1256	52.24%
A-n45-k7	2177	30.67%	B-n45-k6	1412	30.26%	P-n50-k8	1475	56.25%
A-n46-k7	2188	48.04%	B-n50-k7	2343	73.17%	P-n50-k10	1513	54.70%
A-n48-k7	2317	39.83%	B-n50-k8	2461	33.53%	P-n51-k10	1607	53.63%
A-n53-k7	2351	39.28%	B-n51-k7	2737	68.85%	P-n55-k7	1352	55.58%
A-n54-k7	2486	33.08%	B-n52-k7	2245	60.36%	P-n55-k10	1566	54.29%
A-n55-k9	2617	54.03%	B-n56-k7	2100	59.33%	P-n60-k10	1681	47.07%
A-n60-k9	3021	43.65%	B-n57-k7	3262	52.22%	P-n60-k15	1681	25.64%
A-n61-k9	2530	42.45%	B-n57-k9	2918	29.86%	P-n65-k10	1917	59.35%
A-n62-k8	2974	40.88%	B-n63-k10	3357	43.46%	P-n70-k10	1935	46.59%
A-n63-k9	3186	28.62%	B-n64-k9	2480	64.13%	P-n76-k4	1609	45.48%
A-n63-k10	2832	36.02%	B-n66-k9	2685	36.23%	P-n76-k5	1777	59.23%
A-n64-k9	3001	39.91%	B-n67-k10	2867	57.35%	P-n101-k4	1960	57.94%