Supplementary material for the article *"An Algebraic Framework for Evolutionary Algorithms in Combinatorial Optimization"*

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In this document we have collected the supplementary material of the article "An Algebraic Framework for Evolutionary Computation".

In particular we provide the following data.

- The lists of the NKL instances used for the SMAC calibrations and the algorithms comparison in, respectively, Tables 1 and 2. The files of these instances are available from http://web.mst.edu/ tauritzd/CBBOC/GECCO2015/problems.tar.gz.
- The lists of the PFSP instances used for the SMAC calibrations and the algorithms comparison in, respectively, Tables 3 and 4. The files of these instances are available from http://mistic.heig-vd.ch/taillard/problemes.dir/ordonnancement.dir/ordonnancement.html.
- The lists of the LOP instances used for the SMAC calibrations and the algorithms comparison in, respectively, Tables 5 and 6. The files of these instances are available from http://www.optsicom.es/lolib/#instances.
- The ARPDs obtained in standalone algorithms comparison on the NKL instances are shown in Tables 7 and 8 for the termination criteria based on, respectively, a budget of evaluations and a budget of computational time.

- The ARPDs obtained in standalone algorithms comparison on the PFSP instances are shown in Tables 9 and 10 for the termination criteria based on, respectively, a budget of evaluations and a budget of computational time.
- The ARPDs obtained in standalone algorithms comparison on the LOP instances are shown in Tables 11 and 12 for the termination criteria based on, respectively, a budget of evaluations and a budget of computational time.
- The ARPDs obtained in enhanced algorithms comparison on the NKL instances are shown in Table 13.
- The ARPDs obtained in enhanced algorithms comparison on the PFSP instances are shown in Table 14.
- The ARPDs obtained in enhanced algorithms comparison on the LOP instances are shown in Table 15.
- The comparison with best known solutions for the NKL instances is provided in Table 16.
- The comparison with best known solutions for the PFSP instances is provided in Table 17.
- The comparison with best known solutions for the LOP instances is provided in Table 18.

Table 1: NKL instances selected for parameters tuning

Instance	n	K	Instance	n	K
p1/training/00000.txt	126	2	p8/training/00001.txt	209	4
p1/training/00001.txt	126	2	p9/training/00000.txt	294	4
p2/training/00000.txt	136	3	p9/training/00001.txt	294	4
p2/training/00001.txt	136	3	p10/training/00000.txt	300	3
p3/training/00000.txt	242	1	p10/training/00001.txt	300	3
p3/training/00001.txt	242	1	p11/training/00000.txt	192	3
p4/training/00000.txt	250	5	p12/training/00000.txt	199	1
p4/training/00001.txt	250	5	p13/training/00000.txt	96	4
p5/training/00000.txt	52	3	p14/training/00000.txt	126	1
p5/training/00001.txt	52	3	p15/training/00000.txt	144	5
p6/training/00000.txt	231	1	p16/training/00000.txt	66	3
p6/training/00001.txt	231	1	p17/training/00000.txt	232	3
p7/training/00000.txt	111	1	p18/training/00000.txt	138	1
p7/training/00001.txt	111	1	p19/training/00000.txt	181	2
p8/training/00000.txt	209	4	p20/training/00000.txt	171	2

Table 2: NKL instances selected for algorithms comparison

Instance	n	K	Instance	n	K
p1/testing/00000.txt	126	2	p11/testing/00000.txt	192	3
p1/testing/00001.txt	126	2	p11/testing/00001.txt	192	3
p1/testing/00002.txt	126	2	p11/testing/00002.txt	192	3
p2/testing/00000.txt	136	3	p12/testing/00000.txt	199	1
p2/testing/00001.txt	136	3	p12/testing/00001.txt	199	1
p2/testing/00002.txt	136	3	p12/testing/00002.txt	199	1
p3/testing/00000.txt	242	1	p13/testing/00000.txt	96	4
p3/testing/00001.txt	242	1	p13/testing/00001.txt	96	4
p3/testing/00002.txt	242	1	p13/testing/00002.txt	96	4
p4/testing/00000.txt	250	5	p14/testing/00000.txt	126	1
p4/testing/00001.txt	250	5	p14/testing/00001.txt	126	1
p4/testing/00002.txt	250	5	p14/testing/00002.txt	126	1
p5/testing/00000.txt	52	3	p15/testing/00000.txt	144	5
p5/testing/00001.txt	52	3	p15/testing/00001.txt	144	5
p5/testing/00002.txt	52	3	p15/testing/00002.txt	144	5
p6/testing/00000.txt	231	1	p16/testing/00000.txt	66	3
p6/testing/00001.txt	231	1	p16/testing/00001.txt	66	3
p6/testing/00002.txt	231	1	p16/testing/00002.txt	66	3
p7/testing/00000.txt	111	1	p17/testing/00000.txt	232	3
p7/testing/00001.txt	111	1	p17/testing/00001.txt	232	3
p7/testing/00002.txt	111	1	p17/testing/00002.txt	232	3
p8/testing/00000.txt	209	4	p18/testing/00000.txt	138	1
p8/testing/00001.txt	209	4	p18/testing/00001.txt	138	1
p8/testing/00002.txt	209	4	p18/testing/00002.txt	138	1
p9/testing/00000.txt	294	4	p19/testing/00000.txt	181	2
p9/testing/00001.txt	294	4	p19/testing/00001.txt	181	2
p9/testing/00002.txt	294	4	p19/testing/00002.txt	181	2
p10/testing/00000.txt	300	3	p20/testing/00000.txt	171	2
p10/testing/00001.txt	300	3	p20/testing/00001.txt	171	2
p10/testing/00002.txt	300	3	p20/testing/00002.txt	171	2

Table 3: PFSP instances selected for parameters tuning

Instance	n	m	Instance	n	m
tai_20_5_7	20	5	tai_50_10_9	50	10
tai_20_5_8	20	5	tai_50_20_6	50	20
tai_20_5_9	20	5	tai_50_20_7	50	20
tai_20_10_7	20	10	tai_50_20_8	50	20
tai_20_10_8	20	10	tai_50_20_9	50	20
tai_20_10_9	20	10	tai_100_5_7	100	5
tai_20_20_6	20	20	tai_100_5_8	100	5
tai_20_20_7	20	20	tai_100_5_9	100	5
tai_20_20_8	20	20	tai_100_10_7	100	10
tai_20_20_9	20	20	tai_100_10_8	100	10
tai_50_5_7	50	5	tai_100_10_9	100	10
tai_50_5_8	50	5	tai_100_20_6	100	20
tai_50_5_9	50	5	tai_100_20_7	100	20
tai_50_10_7	50	10	tai_100_20_8	100	20
tai_50_10_8	50	10	tai_100_20_9	100	20

Table 4: PFSP instances selected for algorithms comparison

Instance	n	m	Instance	n	m
tai_20_5_0	20	5	tai_50_10_3	50	10
tai_20_5_1	20	5	tai_50_10_4	50	10
tai_20_5_2	20	5	tai_50_10_5	50	10
tai_20_5_3	20	5	tai_50_10_6	50	10
tai_20_5_4	20	5	tai_50_20_0	50	20
tai_20_5_5	20	5	tai_50_20_1	50	20
tai_20_5_6	20	5	tai_50_20_2	50	20
tai_20_10_0	20	10	tai_50_20_3	50	20
tai_20_10_1	20	10	tai_50_20_4	50	20
tai_20_10_2	20	10	tai_50_20_5	50	20
tai_20_10_3	20	10	tai_100_5_0	100	5
tai_20_10_4	20	10	tai_100_5_1	100	5
tai_20_10_5	20	10	tai_100_5_2	100	5
tai_20_10_6	20	10	tai_100_5_3	100	5
tai_20_20_0	20	20	tai_100_5_4	100	5
tai_20_20_1	20	20	tai_100_5_5	100	5
tai_20_20_2	20	20	tai_100_5_6	100	5
tai_20_20_3	20	20	tai_100_10_0	100	10
tai_20_20_4	20	20	tai_100_10_1	100	10
tai_20_20_5	20	20	tai_100_10_2	100	10
tai_50_5_0	50	5	tai_100_10_3	100	10
tai_50_5_1	50	5	tai_100_10_4	100	10
tai_50_5_2	50	5	tai_100_10_5	100	10
tai_50_5_3	50	5	tai_100_10_6	100	10
tai_50_5_4	50	5	tai_100_20_0	100	20
tai_50_5_5	50	5	tai_100_20_1	100	20
tai_50_5_6	50	5	tai_100_20_2	100	20
tai_50_10_0	50	10	tai_100_20_3	100	20
tai_50_10_1	50	10	tai_100_20_4	100	20
tai_50_10_2	50	10	tai_100_20_5	100	20

Table 5: LOP instances selected for parameters tuning

Instance	n	Instance	n
IO/N-t70u11xx	44	IO/N-stabu75	60
IO/N-t70w11xx	44	SGB/N-sgb75.18	75
IO/N-t70x11xx	44	SGB/N-sgb75.19	75
IO/N-t74d11xx	44	SGB/N-sgb75.20	75
IO/N-t75d11xx	44	SGB/N-sgb75.21	75
IO/N-t75e11xx	44	SGB/N-sgb75.22	75
IO/N-t75i11xx	44	SGB/N-sgb75.23	75
IO/N-t75k11xx	44	SGB/N-sgb75.24	75
IO/N-t75n11xx	44	SGB/N-sgb75.25	75
IO/N-t75u11xx	44	MB/N-r100d2	100
IO/N-be75tot	50	MB/N-r100e2	100
IO/N-tiw56r58	56	MB/N-r150d0	150
IO/N-tiw56r66	56	MB/N-r150d1	150
IO/N-tiw56r67	56	MB/N-r150e0	150
IO/N-tiw56r72	56	MB/N-r150e1	150

Table 6: LOP instances selected for algorithms comparison

Instance	n	Instance	n
IO/N-t59b11xx	44	IO/N-tiw56r54	56
IO/N-t59d11xx	44	IO/N-stabu70	60
IO/N-t59f11xx	44	IO/N-stabu74	60
IO/N-t59i11xx	44	SGB/N-sgb75.01	75
IO/N-t59n11xx	44	SGB/N-sgb75.02	75
IO/N-t65b11xx	44	SGB/N-sgb75.03	75
IO/N-t65d11xx	44	SGB/N-sgb75.04	75
IO/N-t65f11xx	44	SGB/N-sgb75.05	75
IO/N-t65i11xx	44	SGB/N-sgb75.06	75
IO/N-t65l11xx	44	SGB/N-sgb75.07	75
IO/N-t65n11xx	44	SGB/N-sgb75.08	75
IO/N-t65w11xx	44	SGB/N-sgb75.09	75
IO/N-t69r11xx	44	SGB/N-sgb75.10	75
IO/N-t70b11xx	44	SGB/N-sgb75.11	75
IO/N-t70d11xx	44	SGB/N-sgb75.12	75
IO/N-t70d11xxb	44	SGB/N-sgb75.13	75
IO/N-t70f11xx	44	SGB/N-sgb75.14	75
IO/N-t70i11xx	44	SGB/N-sgb75.15	75
IO/N-t70k11xx	44	SGB/N-sgb75.16	75
IO/N-t70l11xx	44	SGB/N-sgb75.17	75
IO/N-t70n11xx	44	IO/N-usa79	79
IO/N-be75eec	50	MB/N-r100a2	100
IO/N-be75np	50	MB/N-r100b2	100
IO/N-be75oi	50	MB/N-r100c2	100
IO/N-tiw56n54	56	MB/N-r150a0	150
IO/N-tiw56n58	56	MB/N-r150a1	150
IO/N-tiw56n62	56	MB/N-r150b0	150
IO/N-tiw56n66	56	MB/N-r150b1	150
IO/N-tiw56n67	56	MB/N-r150c0	150
IO/N-tiw56n72	56	MB/N-r150c1	150

Table 7: Experimental results for standalone algorithms' comparison on NKL instances with budget of evaluations

Instance	ADE	BDE	AM-DE	APSO	BPSO	AM-PSO
p1/testing/00000.txt	0.2	10.57	11.18	0.46	4.23	10.1
p1/testing/00001.txt	0.05	8.9	9.51	0.24	3.45	8.93
p1/testing/00002.txt	0.14	5.98	6.32	0.21	2.27	6.03
p2/testing/00000.txt	0.04	11.9	12.46	0.69	5.81	11.67
p2/testing/00001.txt	0.15	13.51	13.78	1.1	6.94	12.91
p2/testing/00002.txt	0.16	13.28	13.97	0.62	6.83	13.75
p3/testing/00000.txt	0	9.79	9.96	0	4.88	9.57
p3/testing/00001.txt	0	12.94	13.04	0	6.75	12.43
p3/testing/00002.txt	0	21.1	21.4	0	10.31	20.6
p4/testing/00000.txt	0.35	21.1	21.22	2.73	17.82	20.78
p4/testing/00001.txt	0.18	21.1	21.5	3.34	17.67	21.1
p4/testing/00002.txt	0.51	20.83	21.24	2.66	17.42	21.31
p5/testing/00000.txt	0.01	9.92	11.55	0.14	0.06	9.69
p5/testing/00001.txt	0	7.48	7.84	0.18	0	7.57
p5/testing/00002.txt	0.41	5.72	5.94	0.55	0.36	5.49
p6/testing/00000.txt	0	5.98	6.24	0.04	2.92	6.08
p6/testing/00001.txt	0	5.43	5.68	0	2.52	5.59
p6/testing/00002.txt	0	13.61	14.15	0	6.17	13.36
p7/testing/00000.txt	0	11.48	12.63	0.03	2.62	11.45
p7/testing/00001.txt	0.03	11.84	12.95	0	2.55	11.89
p7/testing/00002.txt	0	11.03	12.14	0	2.39	11.39
p8/testing/00000.txt	0.59	22.07	22.92	2.59	16.87	21.99
p8/testing/00001.txt	0.54	23.91	24.48	3.04	18.37	23.79
p8/testing/00002.txt	0.88	20.93	21.66	2	16.51	21.02
p9/testing/00000.txt	0.33	16.56	16.51	1.73	13.59	15.99
p9/testing/00001.txt	0.28	18.58	19	1.75	15.24	18.52
p9/testing/00002.txt	0.18	16.09	16.32	1.13	13.47	16.96
p10/testing/00000.txt	0.79	12.11	12.46	0.8	9.33	12.07
p10/testing/00001.txt	0.09	1.28	1.33	0.09	0.98	1.3
p10/testing/00002.txt	0.13	2.04	2.07	0.17	1.59	2.02
p11/testing/00000.txt	0.16	15.78	15.73	0.96	9.73	15.51
p11/testing/00001.txt	0.11	15.15	15.22	1.07	9.66	14.75
p11/testing/00002.txt	0.13	14.39	14.9	1	9.06	14.81
p12/testing/00000.txt	0	12.27	13.08	0.05	6.07	12.27
p12/testing/00001.txt	0	12.72	13.3	0.05	5.94	12.43
p12/testing/00002.txt	0	12.42	12.98	0.09	6.13	12.4
p13/testing/00000.txt	1.05	13.47	13.84	1.35	5.84	13.32
p13/testing/00001.txt	0.85	9.25	10.49	0.79	4.06	9.76
p13/testing/00002.txt	0.33	12.09	12.88	1.45	4.4	11.83
p14/testing/00000.txt	0	9.55	10.24	0	2.03	9.25
p14/testing/00001.txt	0	9.15	9.66	0	1.97	8.84
p14/testing/00002.txt	0	4.24	4.68	0	1.23	4.12
p15/testing/00000.txt	1.02	17.5	18.52	2.86	12.25	17.32
p15/testing/00001.txt	3.52	16.94	17.74	3.19	12.16	17.95
p15/testing/00002.txt	1.4	17.85	18.34	2.39	12.38	17.89
p16/testing/00000.txt	0.08	6.86	6.86	0.62	0.54	7.55
p16/testing/00001.txt	0	0.49	0.54	0	0.01	0.53
p16/testing/00002.txt	0.08	7.44	8.15	0.16	0.32	8.15
p17/testing/00000.txt	0.23	21.05	21.91	1.63	14.81	21.47
p17/testing/00001.txt	0.39	13.8	14.17	0.88	10.09	13.87
p17/testing/00002.txt	0.12	12.83	13.46	0.77	9.29	13.11
p18/testing/00000.txt	0.01	12.12	12.35	0.01	3.97	11.76
p18/testing/00001.txt	0	2.88	3.07	0	0.65	2.93
p18/testing/00002.txt	0	16.97	18.4	0.02	5.52	17.36
p19/testing/00000.txt	0.02	6.36	6.46	0	3.01	6.07
p19/testing/00001.txt	0	0.47	0.47	0	0.21	0.46
p19/testing/00002.txt	0	8.62	9.26	0	4.47	8.71
p20/testing/00000.txt	0.21	7.39	7.9	0.21	3.46	7.64
p20/testing/00001.txt	0.9	21.07	21.47	0.9	10.62	20.06
p20/testing/00002.txt	0.95	20.94	21.95	0.53	11.03	20.94

Table 8: Experimental results for standalone algorithms' comparison on NKL instances with budget of time

Instance	ADE	BDE	AM-DE	APSO	BPSO	AM-PSO
p1/testing/00000.txt	0.2	10.57	11.18	0.22	4.24	10.1
p1/testing/00001.txt	0.05	8.9	9.51	0.11	3.45	8.93
p1/testing/00002.txt	0.14	5.98	6.32	0.12	2.27	6.03
p2/testing/00000.txt	0.12	11.97	12.53	0.14	5.88	11.74
p2/testing/00001.txt	0.16	13.51	13.79	0.45	6.94	12.92
p2/testing/00002.txt	0.16	13.28	13.97	0.41	6.83	13.75
p3/testing/00000.txt	0	9.79	9.96	0	4.88	9.57
p3/testing/00001.txt	0	12.94	13.04	0	6.75	12.43
p3/testing/00002.txt	0	21.1	21.4	0	10.31	20.6
p4/testing/00000.txt	0.37	21.15	21.27	1.5	17.88	20.84
p4/testing/00001.txt	0.22	21.15	21.55	1.71	17.73	21.16
p4/testing/00002.txt	0.59	20.98	21.38	1.63	17.57	21.45
p5/testing/00000.txt	0	9.92	11.55	0.06	0.06	9.69
p5/testing/00001.txt	0	7.48	7.84	0	0.01	7.57
p5/testing/00002.txt	0	5.72	5.94	0.09	0.36	5.49
p6/testing/00000.txt	0	5.98	6.24	0	2.92	6.08
p6/testing/00001.txt	0	5.43	5.68	0	2.52	5.59
p6/testing/00002.txt	0	13.61	14.15	0	6.17	13.36
p7/testing/00000.txt	0	11.48	12.63	0	2.62	11.45
p7/testing/00001.txt	0.03	11.84	12.95	0	2.55	11.89
p7/testing/00002.txt	0	11.03	12.14	0	2.39	11.39
p8/testing/00000.txt	0.53	22.07	22.92	1.33	16.87	21.99
p8/testing/00001.txt	0.55	23.92	24.5	1.34	18.38	23.81
p8/testing/00002.txt	0.76	20.97	21.7	1.23	16.56	21.06
p9/testing/00000.txt	0.5	16.7	16.65	0.96	13.73	16.13
p9/testing/00001.txt	0.31	18.61	19.02	0.81	15.26	18.54
p9/testing/00002.txt	0.54	16.39	16.62	0.75	13.78	17.26
p10/testing/00000.txt	1.06	12.35	12.7	0.65	9.58	12.31
p10/testing/00001.txt	0.12	1.31	1.36	0.09	1.01	1.33
p10/testing/00002.txt	0.13	2.04	2.07	0.12	1.59	2.02
p11/testing/00000.txt	0.16	15.78	15.73	0.4	9.73	15.51
p11/testing/00001.txt	0.11	15.15	15.22	0.2	9.67	14.75
p11/testing/00002.txt	0.13	14.39	14.9	0.2	9.06	14.81
p12/testing/00000.txt	0	12.27	13.08	0	6.07	12.27
p12/testing/00001.txt	0	12.72	13.3	0.01	5.94	12.43
p12/testing/00002.txt	0	12.42	12.98	0.01	6.13	12.4
p13/testing/00000.txt	1.78	14.11	14.48	1.56	6.53	13.96
p13/testing/00001.txt	1.07	9.76	11	1.07	4.6	10.27
p13/testing/00002.txt	0.78	12.66	13.45	1.37	5.03	12.4
p14/testing/00000.txt	0	9.55	10.24	0	2.03	9.25
p14/testing/00001.txt	0	9.15	9.66	0	1.97	8.84
p14/testing/00002.txt	0	4.24	4.68	0	1.23	4.12
p15/testing/00000.txt	0.35	18.06	19.07	1.7	12.84	17.88
p15/testing/00001.txt	0.56	17.65	18.43	1.94	12.91	18.65
p15/testing/00002.txt	0.44	18.23	18.72	1.27	12.79	18.27
p16/testing/00000.txt	0.08	6.86	6.86	0	0.54	7.55
p16/testing/00001.txt	0	0.49	0.54	0	0.01	0.53
p16/testing/00002.txt	0.08	7.44	8.15	0	0.32	8.15
p17/testing/00000.txt	0.23	21.05	21.91	0.84	14.81	21.47
p17/testing/00001.txt	0.58	13.96	14.33	0.57	10.25	14.03
p17/testing/00002.txt	0.27	12.96	13.6	0.43	9.43	13.24
p18/testing/00000.txt	0.01	12.12	12.35	0	3.97	11.76
p18/testing/00001.txt	0	2.88	3.07	0	0.65	2.93
p18/testing/00002.txt	0	16.97	18.4	0	5.52	17.36
p19/testing/00000.txt	0.02	6.36	6.46	0	3.01	6.07
p19/testing/00001.txt	0	0.47	0.47	0	0.21	0.46
p19/testing/00002.txt	0	8.62	9.26	0	4.47	8.71
p20/testing/00000.txt	0.21	7.39	7.9	0.06	3.46	7.64
p20/testing/00001.txt	0.9	21.07	21.47	0.23	10.62	20.06
p20/testing/00002.txt	0.95	20.94	21.95	0.42	11.03	20.94

Table 9: Experimental results for standalone algorithms' comparison on PFSP instances with budget of evaluations

Instance	ADE	RK-DE	APSO	RK-PSO
tai20_5_0	0.14	8.86	1.05	1.65
tai20_5_1	0.25	7.52	2.53	3.66
tai20_5_2	0.4	9.94	3.04	3.46
tai20_5_3	0.21	8.88	1.87	2.47
tai20_5_4	0.32	9.34	0.98	1.78
tai20_5_5	0.16	13.41	1.71	2.51
tai20_5_6	0.32	9.61	2.11	3.15
tai20_10_0	0.16	9.55	2.73	4
tai20_10_1	0.64	8.34	3.17	3.44
tai20_10_2	0.4	8.99	2.4	2.35
tai20_10_3	0.65	8.54	3.02	3.72
tai20_10_4	0.3	10.42	2.54	2.81
tai20_10_5	0.33	7.88	2.09	2.49
tai20_10_6	0.1	10.14	2.23	2.83
tai20_20_0	0.5	6.27	2.2	2.75
tai20_20_1	0.18	6.54	2.22	2.57
tai20_20_2	0.01	6.67	2.11	2.39
tai20_20_3	0.15	7.82	1.31	1.8
tai20_20_4	0.29	5.83	1.91	2.22
tai20_20_5	0.36	6.34	2.25	3.23
tai50_5_0	0.32	17.85	6.11	5.86
tai50_5_1	0.47	18.54	6.09	6.59
tai50_5_2	0.44	17.1	5.87	8.34
tai50_5_3	0.33	16.82	6.74	6.88
tai50_5_4	0.37	15.61	5.56	5.84
tai50_5_5	0.34	17.53	5.87	5.54
tai50_5_6	0.34	15.5	5.69	5.51
tai50_10_0	0.93	15.1	7.19	8.45
tai50_10_1	0.87	16.45	7.56	8.18
tai50_10_2	0.48	19.93	9.01	10.21
tai50_10_3	0.49	16.05	7.98	8.35
tai50_10_4	0.52	15.28	7.38	7.85
tai50_10_5	0.59	16.57	7.63	7.83
tai50_10_6	0.49	13.01	5.78	6.23
tai50_20_0	0.7	12.16	6.75	7.21
tai50_20_1	0.61	14.06	6.86	7.47
tai50_20_2	0.45	15.1	7.41	9.05
tai50_20_3	0.92	12.96	6.63	7.36
tai50_20_4	0.57	14.23	6.85	7.56
tai50_20_5	0.36	13.71	6.33	7.26
tai100_5_0	0.52	16.49	8.63	8.72
tai100_5_1	0.37	17.94	8.05	8.91
tai100_5_2	0.19	17.04	7.53	7.94
tai100_5_3	0.27	18.1	8.06	7.11
tai100_5_4	0.42	17.32	7.71	6.96
tai100_5_5	0.29	18.4	8.24	8.62
tai100_5_6	0.5	18.25	8.17	8.31
tai100_10_0	0.47	16.78	8.11	9.98
tai100_10_1	0.66	19.12	9.74	11.43
tai100_10_2	0.62	17.74	9.15	10.47
tai100_10_3	0.42	16.58	8.06	9.66
tai100_10_4	0.46	18.32	9.18	10.42
tai100_10_5	0.47	19.95	9.74	12.21
tai100_10_6	0.41	19.29	8.93	10.56
tai100_20_0	0.86	15.73	8.71	10.61
tai100_20_1	2.77	13.28	6.8	8.72
tai100_20_2	2.5	14.77	8.26	10.09
tai100_20_3	2.56	13.63	7.69	9.32
tai100_20_4	2.68	15.59	8.98	11.21
tai100_20_5	3.08	14.68	8.18	10.47

Table 10: Experimental results for standalone algorithms' comparison on PFSP instances with budget of time

Instance	ADE	RK-DE	APSO	RK-PSO
tai20_5_0	0.14	5.44	0.25	0.34
tai20_5_1	0.24	5.23	0.51	1.36
tai20_5_2	0.4	6.89	0.92	1.09
tai20_5_3	0.18	5.68	0.62	0.79
tai20_5_4	0.31	5.78	0.41	0.57
tai20_5_5	0.16	9.1	0.32	0.36
tai20_5_6	0.2	6.17	0.86	1.23
tai20_10_0	0.16	6.29	0.67	1.2
tai20_10_1	0.59	5.67	1.71	1.57
tai20_10_2	0.4	5.87	0.63	1.05
tai20_10_3	0.12	5.87	0.94	0.94
tai20_10_4	0.27	6.87	0.67	0.75
tai20_10_5	0.24	5.43	0.8	0.84
tai20_10_6	0.09	6.61	0.39	0.93
tai20_20_0	0.48	4.7	1.18	1
tai20_20_1	0.1	4.62	0.57	0.77
tai20_20_2	0.01	4.66	0.55	0.75
tai20_20_3	0.15	5.16	0.44	0.4
tai20_20_4	0.21	4.12	0.79	0.61
tai20_20_5	0.29	4.51	0.5	1.4
tai50_5_0	0.32	15.06	4.17	3.27
tai50_5_1	0.47	15.53	4	3.74
tai50_5_2	0.44	14.55	4.54	7.06
tai50_5_3	0.33	14.32	4.17	4.65
tai50_5_4	0.37	13.89	3.64	3.5
tai50_5_5	0.34	14.94	3.27	3.84
tai50_5_6	0.34	13.19	3.55	3.37
tai50_10_0	0.42	12.9	5.99	6.58
tai50_10_1	0.87	14.17	5.81	5.28
tai50_10_2	0.48	17.46	6.85	6.95
tai50_10_3	0.49	14.07	5.56	6.04
tai50_10_4	0.51	13.24	5.94	6.12
tai50_10_5	0.59	14.64	5.13	5.92
tai50_10_6	0.48	11.21	4.09	4.35
tai50_20_0	0.47	11.11	5.31	5.99
tai50_20_1	0.5	12.4	5.51	5.83
tai50_20_2	0.45	13.39	6.05	7.14
tai50_20_3	0.73	11.37	5.2	5.86
tai50_20_4	0.28	12.33	4.84	5.53
tai50_20_5	0.36	11.88	4.82	5.29
tai100_5_0	0.52	15.04	8.11	6.88
tai100_5_1	0.37	16.44	7.8	7.86
tai100_5_2	0.19	15.65	7.5	6.44
tai100_5_3	0.27	16.57	7.84	6.03
tai100_5_4	0.42	16.06	7.44	5.5
tai100_5_5	0.29	16.95	8.06	7.15
tai100_5_6	0.5	16.44	7.44	6.82
tai100_10_0	0.47	15.47	7.79	8.71
tai100_10_1	0.66	17.81	8.91	9.5
tai100_10_2	0.62	16.48	8.85	8.19
tai100_10_3	0.34	15.43	7.93	8.67
tai100_10_4	0.46	17.15	8.38	8.19
tai100_10_5	0.47	18.56	9.29	10.43
tai100_10_6	0.41	18.03	9.19	9.13
tai100_20_0	0.52	14.76	8.74	9.51
tai100_20_1	0.77	14.25	8.15	9.5
tai100_20_2	0.48	13.79	7.81	8.48
tai100_20_3	0.5	13.11	7.91	8.98
tai100_20_4	0.53	15	8.26	10.4
tai100_20_5	0.26	13.8	7.64	9.2

Table 11: Experimental results for standalone algorithms' comparison on LOP instances with budget of evaluations

Instance	ADE	RK-DE	APSO	RK-PSO
IO/t59b11xx	0	14.16	3.9	3.97
IO/t59d11xx	0	13.72	4.59	4.85
IO/t59f11xx	0	15.67	2.5	2.42
IO/t59i11xx	0	13.11	1.5	2.34
IO/t59n11xx	0.18	15.12	3.3	3.83
IO/t65b11xx	0.17	16.79	3.64	4.07
IO/t65d11xx	0.23	16.02	2.26	3.56
IO/t65f11xx	0.02	18.18	2.12	3.36
IO/t65i11xx	0	14.94	2.45	2.36
IO/t65l11xx	0	7.3	0.76	1.24
IO/t65n11xx	0.14	16.79	3.97	4.08
IO/t65w11xx	0.09	17.2	2.83	3.23
IO/t69r11xx	0.13	14.53	2.71	2.65
IO/t70b11xx	0	16.6	2.5	2.49
IO/t70d11xx	0.05	15.27	3.99	3.78
IO/t70d11xxb	0.03	17.49	3.32	4.29
IO/t70f11xx	0.24	17.05	3.19	4.15
IO/t70i11xx	0.06	14.99	2.28	1.81
IO/t70k11xx	0	17.22	1.99	3.5
IO/t70l11xx	0	8.52	1.15	2.45
IO/t70n11xx	0.22	16.51	4.28	5.32
IO/be75eec	0.39	23.34	2.03	2.73
IO/be75np	0.01	21.23	1.45	2.05
IO/be75oi	0.02	16.8	1.37	1.85
IO/tiw56n54	0.09	26.33	1.57	2.53
IO/tiw56n58	0.06	26.67	2.03	2.42
IO/tiw56n62	0.03	25.4	2.4	3.52
IO/tiw56n66	0.03	25.52	2.94	3.2
IO/tiw56n67	0.05	24.65	3.06	4.39
IO/tiw56n72	0.03	24.58	3.05	4.44
IO/tiw56r54	0.13	25.52	2.1	3.29
IO/stabu70	0.1	24.55	3	3.12
IO/stabu74	0.03	24.35	3.25	3.67
SGB/sgb75.01	0.25	14.25	5.17	5.07
SGB/sgb75.02	0.21	14.58	3.93	4.92
SGB/sgb75.03	0.35	14.36	5.3	5.27
SGB/sgb75.04	0.32	14.55	4.55	4.85
SGB/sgb75.05	0.29	14.15	4.53	5.5
SGB/sgb75.06	0.36	14.28	4.61	5.35
SGB/sgb75.07	0.26	14.32	4.82	5.69
SGB/sgb75.08	0.35	14.12	5.31	5.46
SGB/sgb75.09	0.32	14.04	4.11	5.55
SGB/sgb75.10	0.25	14.8	5.11	5.25
SGB/sgb75.11	0.4	14.9	5	5.55
SGB/sgb75.12	0.44	14.59	5.56	6.23
SGB/sgb75.13	0.38	14.69	5.28	6.03
SGB/sgb75.14	0.36	14.29	4.45	4.75
SGB/sgb75.15	0.29	14.19	5.1	5.02
SGB/sgb75.16	0.29	14.54	5.98	6.74
SGB/sgb75.17	0.32	14.4	5.46	6.44
IO/usa79	0.14	21.88	3.91	4.64
MB/r100a2	0.02	28.88	3.63	4.22
MB/r100b2	0.03	28.12	3.39	4.52
MB/r100c2	0.02	29.69	3.34	3.77
MB/r150a0	0	35.54	4.56	4.49
MB/r150a1	0.01	34.15	3.88	4.78
MB/r150b0	0.01	34.77	4.33	4.76
MB/r150b1	0.01	32.38	4.2	5.36
MB/r150c0	0.01	34.6	4.14	4.85
MB/r150c1	0.02	32.73	4.28	4.48

Table 12: Experimental results for standalone algorithms' comparison on LOP instances with budget of time

Instance	ADE	RK-DE	APSO	RK-PSO
IO/t59b11xx	0	11.12	2.99	3.16
IO/t59d11xx	0	10.39	3.94	3.97
IO/t59f11xx	0	12.48	2.2	2.49
IO/t59i11xx	0	10.2	1.06	1.32
IO/t59n11xx	0.15	12.53	2.55	2.88
IO/t65b11xx	0.15	13.9	3.21	3.31
IO/t65d11xx	0.23	12.85	2.17	2.32
IO/t65f11xx	0.09	15.19	1.67	2.38
IO/t65i11xx	0	12.32	1.71	2.25
IO/t65l11xx	0	5.64	0.71	0.86
IO/t65n11xx	0.14	13.7	3.37	4.02
IO/t65w11xx	0.08	13.86	2.59	2.65
IO/t69r11xx	0.13	11.69	2.14	2.76
IO/t70b11xx	0	13.59	1.48	2.15
IO/t70d11xx	0.04	12.32	2.69	2.85
IO/t70d11xxb	0.03	13.81	2.72	3.23
IO/t70f11xx	0.21	14.02	2.75	2.3
IO/t70i11xx	0.07	12.16	1.6	1.98
IO/t70k11xx	0	13.93	2.05	1.84
IO/t70l11xx	0	6.57	0.99	0.88
IO/t70n11xx	0.18	13.83	3.33	3.75
IO/be75eec	0.25	19.37	1.23	1.56
IO/be75np	0	16.83	0.99	0.65
IO/be75oi	0.01	13.04	0.93	1.13
IO/tiw56n54	0.08	21.9	1.23	1.41
IO/tiw56n58	0.06	22.65	1.68	2
IO/tiw56n62	0.03	21.76	1.58	1.69
IO/tiw56n66	0.03	21.34	1.91	1.88
IO/tiw56n67	0.05	20.2	2.69	2.81
IO/tiw56n72	0.03	20.54	2.66	2.91
IO/tiw56r54	0.12	21.27	1.73	1.73
IO/stabu70	0.08	20.72	2.5	2.69
IO/stabu74	0.03	20.2	2.29	2.24
SGB/sgb75.01	0.13	12.96	3.84	4.44
SGB/sgb75.02	0.09	13.21	3.45	3.38
SGB/sgb75.03	0.15	12.95	4.07	4.1
SGB/sgb75.04	0.1	12.86	4.03	3.91
SGB/sgb75.05	0.12	12.88	3.89	4.18
SGB/sgb75.06	0.14	12.92	4.01	3.6
SGB/sgb75.07	0.19	12.95	3.93	4.65
SGB/sgb75.08	0.18	12.54	4.18	4.56
SGB/sgb75.09	0.11	12.57	3.59	3.72
SGB/sgb75.10	0.12	13.11	4.21	4.77
SGB/sgb75.11	0.12	13.14	4.27	3.96
SGB/sgb75.12	0.21	12.84	4.57	4.69
SGB/sgb75.13	0.16	13.46	4.68	5.05
SGB/sgb75.14	0.17	12.81	4.01	3.95
SGB/sgb75.15	0.13	12.87	4.12	4.54
SGB/sgb75.16	0.19	13.07	4.52	4.93
SGB/sgb75.17	0.11	12.73	4.61	4.71
IO/usa79	0.14	19.6	3.6	3.15
MB/r100a2	0.02	27.7	3.29	3.11
MB/r100b2	0.03	26.7	2.93	3.42
MB/r100c2	0.02	28.15	3.02	3.1
MB/r150a0	0	34.58	4.23	4.42
MB/r150a1	0.01	33.1	3.65	4.13
MB/r150b0	0.01	33.66	4.35	3.96
MB/r150b1	0.01	31.6	4.29	4.29
MB/r150c0	0.01	33.52	4.25	4.11
MB/r150c1	0.02	31.7	4.26	4.1

Table 13: Experimental results for enhanced algorithms' comparison on NKL instances

Instance	ADE$^+$	BDE$^+$	AM-DE$^+$	APSO$^+$	BPSO$^+$	AM-PSO$^+$
p1/testing/00000.txt	0.12	11.33	11.72	0.1	0.48	2.32
p1/testing/00001.txt	0.05	9.15	10.1	0.08	0.28	2.03
p1/testing/00002.txt	0.03	6.17	6.72	0.08	0.22	1.92
p2/testing/00000.txt	0.03	12.47	13.35	0.05	0.84	4.41
p2/testing/00001.txt	0.01	13.98	14.97	0.12	1.05	4.6
p2/testing/00002.txt	0	13.72	14.36	0.2	0.84	5.3
p3/testing/00000.txt	0	9.61	10.34	0	0	1.53
p3/testing/00001.txt	0	13.09	13.11	0	0.02	1.66
p3/testing/00002.txt	0	21.15	22.14	0	0.03	1.55
p4/testing/00000.txt	0.37	21.87	22.47	0.59	3.51	8.35
p4/testing/00001.txt	0.3	21.57	22.51	0.75	4.44	8.58
p4/testing/00002.txt	0.49	21.45	22.64	0.88	4.11	8.18
p5/testing/00000.txt	0	9.73	12.13	0.05	0.12	5.21
p5/testing/00001.txt	0	7.19	9.32	0	0.02	5.06
p5/testing/00002.txt	0	5.95	7.03	0	0.54	3.56
p6/testing/00000.txt	0	6.15	6.46	0.01	0.11	1.42
p6/testing/00001.txt	0	5.63	5.92	0	0.04	1.16
p6/testing/00002.txt	0	13.75	14.81	0	0.17	2.99
p7/testing/00000.txt	0	12.15	12.99	0	0.15	1.26
p7/testing/00001.txt	0	12.47	14.52	0	0	1.81
p7/testing/00002.txt	0	11.83	12.78	0	0	1.45
p8/testing/00000.txt	0.45	23.03	23.92	0.48	3.5	8.04
p8/testing/00001.txt	0.62	24.73	26.01	0.75	4.25	9.58
p8/testing/00002.txt	0.82	22.34	23.39	0.83	3.65	8.52
p9/testing/00000.txt	0.73	16.95	17.4	0.72	2.7	5.71
p9/testing/00001.txt	0.44	18.86	19.55	0.26	2.95	6.44
p9/testing/00002.txt	0.5	17.26	17.54	0.61	2.71	6.01
p10/testing/00000.txt	0.31	12.65	13.18	0.75	2.33	4.62
p10/testing/00001.txt	0.02	1.34	1.4	0.07	0.25	0.55
p10/testing/00002.txt	0.05	2.06	2.15	0.1	0.35	0.79
p11/testing/00000.txt	0	16.05	16.38	0.15	1.42	5.11
p11/testing/00001.txt	0	15.59	15.99	0.12	1.5	5.59
p11/testing/00002.txt	0.04	15.04	15.81	0.16	1.31	4.1
p12/testing/00000.txt	0	12.86	13.87	0	0.06	1.51
p12/testing/00001.txt	0	12.9	13.8	0	0.13	1.32
p12/testing/00002.txt	0	12.98	13.85	0	0.17	1.56
p13/testing/00000.txt	0.59	15.04	16.15	1.3	3.3	8.28
p13/testing/00001.txt	0.78	11.38	12.27	1	2.96	6.83
p13/testing/00002.txt	0.29	13.09	13.81	0.88	2.35	6.82
p14/testing/00000.txt	0	10.14	10.81	0	0	0.74
p14/testing/00001.txt	0	9.63	10.7	0	0	1.05
p14/testing/00002.txt	0	4.48	4.9	0	0	0.93
p15/testing/00000.txt	0.62	18.48	19.92	0.87	3.91	8.84
p15/testing/00001.txt	0.53	18.65	19.65	1.01	4.8	10.54
p15/testing/00002.txt	0.39	19.06	20.24	0.64	3.99	8.6
p16/testing/00000.txt	0	7.17	8.17	0	0.85	4.08
p16/testing/00001.txt	0	0.52	0.63	0	0.01	0.28
p16/testing/00002.txt	0	8.23	9.14	0	0.28	5.42
p17/testing/00000.txt	0.28	21.51	22.84	0.37	2.2	6.4
p17/testing/00001.txt	0.17	14.29	14.78	0.25	1.58	4.11
p17/testing/00002.txt	0.05	13.5	13.98	0.13	1.3	3.81
p18/testing/00000.txt	0	12.13	13.09	0	0.2	1.92
p18/testing/00001.txt	0	3	3.52	0	0.02	0.49
p18/testing/00002.txt	0	18.39	19.58	0.01	0.09	3.26
p19/testing/00000.txt	0	6.59	6.97	0	0.18	2.14
p19/testing/00001.txt	0	0.47	0.51	0	0.02	0.17
p19/testing/00002.txt	0	8.95	9.8	0	0.41	3.16
p20/testing/00000.txt	0	7.83	8.27	0.06	0.62	2.62
p20/testing/00001.txt	0.17	22.15	22.8	0.14	1.78	7.15
p20/testing/00002.txt	0.24	21.5	23.79	0.27	1.96	7.71

Table 14: Experimental results for enhanced algorithms' comparison on PFSP instances

Instance	ADE$^+$	RK-DE$^+$	APSO$^+$	RK-PSO$^+$
tai20_5_0	0.01	0.61	0.05	0.50
tai20_5_1	0.02	1.84	0.06	1.33
tai20_5_2	0.01	5.28	0.14	1.36
tai20_5_3	0	0.87	0.25	0.56
tai20_5_4	0	1.02	0.01	0.78
tai20_5_5	0.01	0.66	0.01	0.78
tai20_5_6	0.05	2.21	0.24	1.78
tai20_10_0	0	1.41	0.14	1.27
tai20_10_1	0	1.70	0.43	1.82
tai20_10_2	0.05	1.06	0.29	1.10
tai20_10_3	0.33	0.78	0.65	0.78
tai20_10_4	0.01	0.85	0.28	0.84
tai20_10_5	0.17	2.53	0.50	1.40
tai20_10_6	0.02	1.18	0.09	0.60
tai20_20_0	0	1.97	0.38	1.97
tai20_20_1	0.02	1.09	0.10	0.90
tai20_20_2	0	1.82	0.02	1.20
tai20_20_3	0.07	0.75	0.10	0.29
tai20_20_4	0.02	0.78	0.23	0.75
tai20_20_5	0	0.81	0.06	0.71
tai50_5_0	0.72	1.45	1.35	1.41
tai50_5_1	0.45	0.45	0.45	0.45
tai50_5_2	0.24	0.09	0.16	0.09
tai50_5_3	0.33	0.87	0.87	0.84
tai50_5_4	0.51	1.15	1.15	1.14
tai50_5_5	0.15	1.29	1.26	1.32
tai50_5_6	1.28	1.58	1.53	1.52
tai50_10_0	0.03	0.01	0.02	0
tai50_10_1	0.37	0.38	0.37	0.36
tai50_10_2	1.48	2.48	2.78	2.27
tai50_10_3	1.19	1.39	1.44	1.38
tai50_10_4	0.96	1.51	1.50	1.51
tai50_10_5	1.37	2.24	2.01	2.11
tai50_10_6	0.93	2.00	1.47	1.80
tai50_20_0	1.00	1.48	1.05	1.06
tai50_20_1	0.67	1.40	1.28	1.38
tai50_20_2	1.02	0.89	1.10	1.12
tai50_20_3	0.90	1.82	1.33	1.47
tai50_20_4	1.04	1.40	1.44	1.36
tai50_20_5	1.46	1.65	1.06	1.94
tai100_5_0	0.04	0.04	0.04	0.03
tai100_5_1	0.03	0.17	0.18	0.18
tai100_5_2	0	0.02	0.01	0.01
tai100_5_3	0.20	0.14	0.19	0.14
tai100_5_4	0.32	0.36	0.36	0.34
tai100_5_5	0.04	0.05	0.05	0.04
tai100_5_6	0.31	0.38	0.38	0.38
tai100_10_0	0.45	0.53	0.62	0.65
tai100_10_1	0.16	0.16	0.17	0.16
tai100_10_2	0.13	0.21	0.17	0.14
tai100_10_3	0.18	0.17	0.18	0.24
tai100_10_4	0.38	0.42	0.53	0.53
tai100_10_5	0.53	0.57	0.70	0.84
tai100_10_6	0.89	0.76	0.08	0.80
tai100_20_0	0.70	1.41	1.29	1.20
tai100_20_1	1.21	1.36	1.19	1.28
tai100_20_2	0.61	0.01	0.67	0.59
tai100_20_3	0.92	1.09	0.02	0.84
tai100_20_4	1.00	0.53	0.69	0.68
tai100_20_5	0.48	0.62	0.02	0.55

Table 15: Experimental results for enhanced algorithms' comparison on LOP instances

Instance	ADE$^+$	RK-DE$^+$	APSO$^+$	RK-PSO$^+$
IO/N-t59b11xx	0	2.42	0.15	0.21
IO/N-t59d11xx	0	0.66	0.60	0.65
IO/N-t59f11xx	0	0.02	0.02	0
IO/N-t59i11xx	0	0	0.04	0.04
IO/N-t59n11xx	0	0.07	0.19	0.09
IO/N-t65b11xx	0.01	0.03	0.23	0.02
IO/N-t65d11xx	0	0	0.14	0
IO/N-t65f11xx	0.15	0.31	0.22	0.26
IO/N-t65i11xx	0	0.02	0.02	0.02
IO/N-t65l11xx	0	0	0	0.01
IO/N-t65n11xx	0	0.20	0.19	0.21
IO/N-t65w11xx	0	0.33	0.09	0.19
IO/N-t69r11xx	0	1.14	0.54	1.10
IO/N-t70b11xx	0.01	0.12	0.08	0.10
IO/N-t70d11xx	0.01	0.13	0.04	0.13
IO/N-t70d11xxb	0	0.07	0.06	0.07
IO/N-t70f11xx	0	0	0.02	0
IO/N-t70i11xx	0	0.64	0.09	0.23
IO/N-t70k11xx	0	0	0.03	0
IO/N-t70l11xx	0	0	0	0
IO/N-t70n11xx	0.01	0.21	0.20	0.24
IO/N-be75eec	0.02	0.13	0.21	0.14
IO/N-be75np	0	0.17	0.08	0.15
IO/N-be75oi	0	0.18	0.14	0.19
IO/N-tiw56n54	0.01	0.87	0.23	0.84
IO/N-tiw56n58	0	0.05	0.11	0.06
IO/N-tiw56n62	0.02	0.14	0.10	0.13
IO/N-tiw56n66	0	1.03	0.46	0.98
IO/N-tiw56n67	0.01	0.28	0.27	0.29
IO/N-tiw56n72	0	2.02	1.40	1.55
IO/N-tiw56r54	0	0.37	0.30	0.32
IO/N-stabu70	0	0.26	0.32	0.36
IO/N-stabu74	0.02	0.07	0.02	0
SGB/N-sgb75.01	0.03	0.02	0.04	0.02
SGB/N-sgb75.02	0.02	0.13	0.16	0.15
SGB/N-sgb75.03	0.01	0.15	0.13	0.13
SGB/N-sgb75.04	0	0	0	0.02
SGB/N-sgb75.05	0.01	1.00	1.00	1.02
SGB/N-sgb75.06	0	0.01	0.01	0
SGB/N-sgb75.07	0.02	1.22	1.06	1.24
SGB/N-sgb75.08	0.05	0.09	0.20	0.20
SGB/N-sgb75.09	0.02	0.15	0.14	0.16
SGB/N-sgb75.10	0.02	0.01	0.07	0
SGB/N-sgb75.11	0	0.23	0.20	0.22
SGB/N-sgb75.12	0	0.14	0.14	0.16
SGB/N-sgb75.13	0	0.10	0.09	0.08
SGB/N-sgb75.14	0	0.16	0.15	0.16
SGB/N-sgb75.15	0.01	0.11	0.09	0.11
SGB/N-sgb75.16	0.04	0.14	0.08	0.06
SGB/N-sgb75.17	0.04	0.95	0.89	0.93
IO/N-usa79	0	0.48	0.40	0.31
MB/N-r100a2	0.02	0.13	0.16	0.14
MB/N-r100b2	0	0.04	0.05	0.07
MB/N-r100c2	0.03	0.11	0.08	0.12
MB/N-r150a0	0	0.03	0.02	0.04
MB/N-r150a1	0	0.03	0.03	0.04
MB/N-r150b0	0	0.01	0	0.01
MB/N-r150b1	0	0.02	0.02	0.03
MB/N-r150c0	0	0	0	0
MB/N-r150c1	0.01	0.04	0.02	0.03

Table 16: Comparison with best known solutions on NKL instances

Instance	ADE$^+$	APSO$^+$	B.K.S.
p1/testing/00000.txt	90.4233	90.4267	90.3235
p1/testing/00001.txt	93.5641	93.5641	93.3318
p1/testing/00002.txt	79.4437	79.4437	79.1587
p2/testing/00000.txt	91.1622	91.1622	88.9509
p2/testing/00001.txt	92.7212	92.7212	90.5231
p2/testing/00002.txt	91.8354	91.8354	89.4817
p3/testing/00000.txt	87.9691	87.9691	87.9691
p3/testing/00001.txt	110.1745	110.1745	110.1745
p3/testing/00002.txt	156.1609	156.1609	156.1609
p4/testing/00000.txt	183.8427	183.6278	172.8487
p4/testing/00001.txt	184.2854	184.0893	171.5434
p4/testing/00002.txt	185.3958	184.9899	175.3365
p5/testing/00000.txt	35.1346	35.1346	34.3652
p5/testing/00001.txt	31.0654	31.0654	30.7451
p5/testing/00002.txt	45.4039	45.4039	44.906
p6/testing/00000.txt	111.2781	111.2781	111.2781
p6/testing/00001.txt	53.5665	53.5665	53.5665
p6/testing/00002.txt	172.1712	172.1712	172.1712
p7/testing/00000.txt	77.3405	77.3405	77.3051
p7/testing/00001.txt	77.3221	77.3221	77.2223
p7/testing/00002.txt	73.5509	73.5509	73.5509
p8/testing/00000.txt	163.5843	163.5142	155.1124
p8/testing/00001.txt	151.5353	151.4739	143.3207
p8/testing/00002.txt	168.3022	167.9502	158.9551
p9/testing/00000.txt	205.3029	206.1995	199.7327
p9/testing/00001.txt	201.4946	201.6264	195.177
p9/testing/00002.txt	214.9287	214.4713	207.3984
p10/testing/00000.txt	199.6069	199.8812	198.2354
p10/testing/00001.txt	188.5236	188.4692	188.3332
p10/testing/00002.txt	200.2198	200.1282	199.8534
p11/testing/00000.txt	130.6603	130.6603	124.77
p11/testing/00001.txt	129.641	129.641	123.3698
p11/testing/00002.txt	129.9498	129.9495	124.6046
p12/testing/00000.txt	129.3801	129.3801	129.3801
p12/testing/00001.txt	129.9906	129.9906	129.9906
p12/testing/00002.txt	128.4937	128.4937	128.4937
p13/testing/00000.txt	81.2004	81.2004	78.7884
p13/testing/00001.txt	52.0338	52.3257	51.1581
p13/testing/00002.txt	85.5972	85.0384	84.4796
p14/testing/00000.txt	45.7247	45.7247	45.6371
p14/testing/00001.txt	73.9085	73.9085	73.7458
p14/testing/00002.txt	43.6713	43.6713	43.3806
p15/testing/00000.txt	114.5324	114.4005	104.765
p15/testing/00001.txt	110.0384	110.0384	100.1493
p15/testing/00002.txt	117.689	117.5685	106.0642
p16/testing/00000.txt	27.2946	27.2946	26.6637
p16/testing/00001.txt	28.6908	28.6908	28.6482
p16/testing/00002.txt	36.9688	36.9688	36.091
p17/testing/00000.txt	162.6197	162.5879	158.9572
p17/testing/00001.txt	154.8786	154.8738	151.993
p17/testing/00002.txt	148.9982	148.9982	146.6737
p18/testing/00000.txt	122.1414	122.1414	122.1414
p18/testing/00001.txt	119.7083	119.7083	119.7083
p18/testing/00002.txt	30.3497	30.3497	30.3497
p19/testing/00000.txt	103.3213	103.3213	103.1373
p19/testing/00001.txt	102.1973	102.1973	102.1848
p19/testing/00002.txt	96.9572	96.9572	96.5128
p20/testing/00000.txt	129.4775	129.4775	129.2026
p20/testing/00001.txt	111.3975	111.3975	111.3975
p20/testing/00002.txt	148.0896	148.0896	147.2112

Table 17: Comparison with best known solutions on PFSP instances

Instance	ADE$^+$	APSO$^+$	B.K.S.
tai20_5_0	14033	14033	14033
tai20_5_1	15151	15151	15151
tai20_5_2	13301	13301	13301
tai20_5_3	15447	15447	15447
tai20_5_4	13529	13529	13529
tai20_5_5	13123	13123	13123
tai20_5_6	13548	13548	13548
tai20_10_0	20911	20911	20911
tai20_10_1	22440	22440	22440
tai20_10_2	19833	19833	19833
tai20_10_3	18710	18710	18710
tai20_10_4	18641	18641	18641
tai20_10_5	19245	19245	19245
tai20_10_6	18363	18363	18363
tai20_20_0	33623	33623	33623
tai20_20_1	31587	31587	31587
tai20_20_2	33920	33920	33920
tai20_20_3	31661	31661	31661
tai20_20_4	34557	34557	34557
tai20_20_5	32564	32564	32564
tai50_5_0	64902	64938	64803
tai50_5_1	68101	68296	68062
tai50_5_2	63253	64140	63162
tai50_5_3	68354	68876	68226
tai50_5_4	69568	70116	69392
tai50_5_5	67030	67778	66841
tai50_5_6	66476	66496	66253
tai50_10_0	87697	89248	87204
tai50_10_1	82889	83444	82820
tai50_10_2	80337	82191	79987
tai50_10_3	86589	87580	86545
tai50_10_4	86430	87268	86424
tai50_10_5	86958	87458	86637
tai50_10_6	89524	90395	88866
tai50_20_0	126838	127186	125831
tai50_20_1	119280	120217	119247
tai50_20_2	116977	117568	116459
tai50_20_3	121841	122447	120712
tai50_20_4	120006	121554	118184
tai50_20_5	121657	122118	120703
tai100_5_0	256903	256903	253605
tai100_5_1	243800	245207	242579
tai100_5_2	240076	240076	238075
tai100_5_3	230608	230302	227889
tai100_5_4	243985	244535	240589
tai100_5_5	234264	236381	232689
tai100_5_6	242842	243575	240669
tai100_10_0	301067	302379	299101
tai100_10_1	279876	280324	274566
tai100_10_2	291710	291905	288543
tai100_10_3	305448	304965	301552
tai100_10_4	288530	289751	284722
tai100_10_5	273881	275240	270483
tai100_10_6	284436	285963	280257
tai100_20_0	368333	370129	366438
tai100_20_1	381342	378196	373138
tai100_20_2	380548	380982	371206
tai100_20_3	383627	383265	373574
tai100_20_4	380742	378576	369850
tai100_20_5	377160	377613	372752

Table 18: Comparison with best known solutions on LOP instances

Instance	ADE$^+$	APSO$^+$	B.K.S.
IO/N-t59b11xx	209320	209320	209320
IO/N-t59d11xx	147354	147354	147354
IO/N-t59f11xx	122520	122520	122520
IO/N-t59i11xx	8261545	8261545	8261545
IO/N-t59n11xx	20928	20928	20928
IO/N-t65b11xx	356758	356724	356758
IO/N-t65d11xx	237739	237739	237739
IO/N-t65f11xx	217295	217295	217295
IO/N-t65i11xx	14469163	14465551	14469163
IO/N-t65l11xx	16719	16719	16719
IO/N-t65n11xx	32157	32097	32157
IO/N-t65w11xx	138181029	138181029	138181029
IO/N-t69r11xx	771149	771149	771149
IO/N-t70b11xx	528419	528419	528419
IO/N-t70d11xx	376725	376535	376725
IO/N-t70d11xxb	366469	366469	366469
IO/N-t70f11xx	360336	360336	360336
IO/N-t70i11xx	24785782	24785782	24785782
IO/N-t70k11xx	60659200	60659200	60659200
IO/N-t70l11xx	25253	25253	25253
IO/N-t70n11xx	52704	52704	52704
IO/N-be75eec	236464	236273	236464
IO/N-be75np	716994	716994	716994
IO/N-be75oi	111171	111171	111171
IO/N-tiw56n54	91554	91554	91554
IO/N-tiw56n58	125224	125224	125224
IO/N-tiw56n62	176715	176715	176715
IO/N-tiw56n66	226547	226459	226547
IO/N-tiw56n67	226033	226033	226033
IO/N-tiw56n72	365146	365146	365146
IO/N-tiw56r54	102948	102888	102948
IO/N-stabu70	362512	361946	362512
IO/N-stabu74	541393	541393	541393
SGB/N-sgb75.01	2724126	2724114	2724126
SGB/N-sgb75.02	2616392	2616313	2616392
SGB/N-sgb75.03	2747384	2743903	2747384
SGB/N-sgb75.04	2734169	2734082	2734169
SGB/N-sgb75.05	2707863	2703614	2707863
SGB/N-sgb75.06	2707280	2707234	2707280
SGB/N-sgb75.07	2727928	2727928	2727928
SGB/N-sgb75.08	2712837	2712154	2712837
SGB/N-sgb75.09	2687364	2687118	2687364
SGB/N-sgb75.10	2733387	2733387	2733387
SGB/N-sgb75.11	2732686	2732678	2732686
SGB/N-sgb75.12	2692548	2692480	2692548
SGB/N-sgb75.13	2714591	2714588	2714591
SGB/N-sgb75.14	2733171	2731260	2733926
SGB/N-sgb75.15	2732810	2732787	2732810
SGB/N-sgb75.16	2747797	2747030	2747797
SGB/N-sgb75.17	2747864	2747864	2747864
IO/N-usa79	1813986	1813700	1813986
MB/N-r100a2	145270	145092	145270
MB/N-r100b2	143271	143266	143271
MB/N-r100c2	141696	141586	141702
MB/N-r150a0	360978	360953	360978
MB/N-r150a1	349251	349187	349251
MB/N-r150b0	367635	367635	367635
MB/N-r150b1	347627	347627	347627
MB/N-r150c0	363895	363895	363895
MB/N-r150c1	346492	346474	346492