Supplementary Material for Penalty Weights in QUBO formulations of Permutation Problems

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Abstract. This is a supplementary material for paper titled Penalty Weights in QUBO formulations of Permutation Problems. It contains full results of experiments which could not fit in the paper.

Problem	Instances	Optimal	Average Energy (Fitness)					Standard Deviation Fitness				
			MOC	MOMC	MQC	UB	VLM	MOC	MOMC	MQC	UB	VLM
QAP	had12	1,652	1,652	1,652		1,652	1,652	0.00	0.00		0.00	0.00
	had14	2,724	2,724	2,724		2,724	2,724	0.00	0.00		0.00	0.00
	had16	3,720	3,720	3,720		3,720	3,720	0.00	0.00		0.00	0.00
	had18	5,358	5,358	5,358		5,358	5,358	0.00	0.00		0.00	0.00
	had20	6,922	6,922	6,922		6,922	6,922	0.00	0.00		0.00	0.00
	rou12	235,528	235,528	235,528		235,528	235,528	0.00	0.00		0.00	0.00
	rou15	354,210	354,210	354,210		354,210	354,210	0.00	0.00		0.00	0.00
	rou20	725,522	725,522	725,522		725,522	725,522	0.00	0.00		0.00	0.00
	tai40a	3,139,370	3,141,702	3,141,702		3,141,702	3,141,702	0.00	0.00		0.00	0.00
	tai40b	637,250,948	637,250,948	637,250,948		637,250,948	637,250,948	0.00	0.00		0.00	0.00
TSP	bayg29	1,610	1,610	1,610	1,610	1,610	1,610	0.00	0.00	0.00	0.00	0.00
	bays29	2,020	2,020	2,020	2,020	2,020	2,020	0.00	0.00	0.00	0.00	0.00
	berlin52	7,542	7,708	7,998	7,765	7,682	7,856	0.00	0.00	0.00	0.00	0.00
	brazil58	25,395	25,758	25,795	26,241	25,783	25,783	0.00	0.00	0.00	0.00	0.00
	dantzig42	699	699	699	699	699	699	0.00	0.00	0.00	0.00	0.00
	fri26	937	937	937	937	937	937	0.00	0.00	0.00	0.00	0.00
	gr17	2,085	2,085	2,085	2,085	2,085	2,085	0.00	0.00	0.00	0.00	0.00
	gr21	2,707	2,707	2,707	2,707	2,707	2,707	0.00	0.00	0.00	0.00	0.00
	gr24	1,272	1,272	1,272	1,272	1,272	1,272	0.00	0.00	0.00	0.00	0.00
	st70	675	691	691	685	693	691	0.45	0.00	0.00	0.00	0.73

Table 1. Average and standard deviation fitness within $0.03m$ seconds time limit

Problem	Instances	Average Time to Solution					Standard Deviation Time to Solution				
		UB	MQC	VLM	MOMC	MOC	UB	MQC	VLM	MOMC	MOC
QAP	had12	0.20		0.20	0.20	0.21	0.01		0.01	0.01	0.01
	had14	0.22		0.22	0.22	0.22	0.02		0.02	0.02	0.01
	had16	0.25		0.25	0.25	0.25	0.02		0.01	0.01	0.02
	had18	0.31		0.31	0.31	0.31	0.01		0.01	0.01	0.01
	had20	0.38		0.37	0.37	0.38	0.01		0.01	0.01	0.01
	rou12	0.20		0.20	0.20	0.20	0.02		0.01	0.02	0.02
	rou15	0.23		0.23	0.23	0.22	0.02		0.01	0.02	0.02
	rou20	0.37		0.37	0.37	0.37	0.02		0.02	0.02	0.01
	tai40a	19.08		19.07	19.03	5.60	0.16		0.14	0.17	0.08
	tai40b	2.43		2.44	2.43	4.77	0.04		0.04	0.05	0.06
TSP	bayg29	0.47	1.34	0.47	0.48	0.47	0.01	0.07	0.02	0.02	0.02
	bays29	1.34	3.57	1.34	1.34	1.33	0.07	0.14	0.06	0.06	0.06
	berlin52	70.47	64.81	68.17	17.27	53.25	0.92	0.70	1.03	0.25	0.61
	brazil58	73.48	91.83	73.73	49.95	20.04	0.65	1.09	0.59	0.70	0.25
	dantzig42	14.41	19.86	14.50	14.54	45.13	0.35	0.29	0.27	0.16	0.68
	fri26	0.38	0.38	0.38	0.37	0.38	0.01	0.01	0.02	0.02	0.01
	gr17	0.22	0.22	0.22	0.22	0.21	0.01	0.01	0.01	0.01	0.01
	gr21	0.27	0.26	0.26	0.26	0.26	0.02	0.02	0.02	0.02	0.02
	gr24	0.61	0.61	0.61	0.61	0.61	0.03	0.03	0.03	0.03	0.03
	st70	23.60	136.56	124.71	142.34	136.04	0.29	0.76	43.41	0.66	26.41

Table 2. Average and standard deviation of run time (in seconds) to find best solution within $0.03m$ seconds time limit