Detailed Online supplement: The connected Grundy coloring problem: Formulations and a local-search enhanced biased random-key genetic algorithm

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Appendix A IP results for the smaller instances with up to 30 vertices

Table 4: Results using the formulations for the random graphs with at most 30 vertices.

			std				**rep**			
instance	cub	h	best	ub	gap	time	best	ub	gap	time
rand_15_0.2_01	5.0	4.0	4.0	4.0	0.0	5.4	4.0	4.0	0.0	790.6
rand_15_0.2_02	6.0	4.0	4.0	4.0	0.0	90.2	4.0	4.0	0.0	1817.8
rand_15_0.2_03	6.0	4.0	5.0	5.0	0.0	13.0	5.0	6.0	20.0	3600.0
rand_15_0.2_04	5.0	3.0	4.0	4.0	0.0	7.6	4.0	5.0	25.0	3600.0
rand_15_0.2_05	5.0	4.0	4.0	4.0	0.0	4.1	4.0	4.0	0.0	703.4
rand_15_0.4_01	9.0	5.0	7.0	8.0	14.3	3600.0	7.0	8.0	14.3	3600.0
rand_15_0.4_02	8.0	5.0	7.0	8.0	14.3	3600.0	7.0	7.0	0.0	1468.4
rand_15_0.4_03	7.0	5.0	5.0	5.0	0.0	1399.3	5.0	6.0	20.0	3600.0
rand_15_0.4_04	9.0	6.0	7.0	9.0	28.6	3600.0	7.0	7.0	0.0	501.2
rand_15_0.4_05	9.0	6.0	7.0	8.0	14.3	3600.0	7.0	7.0	0.0	748.6
rand_15_0.6_01	11.0	6.0	9.0	11.0	22.2	3600.0	9.0	9.0	0.0	248.2
rand_15_0.6_02	11.0	7.0	9.0	11.0	22.2	3600.0	9.0	9.0	0.0	153.4
rand_15_0.6_03	10.0	7.0	9.0	10.0	11.1	3600.0	9.0	9.0	0.0	215.2
rand_15_0.6_04	9.0	6.0	8.0	9.0	12.5	3600.0	8.0	9.0	12.5	3600.0
rand_15_0.6_05	11.0	7.0	9.0	11.0	22.2	3600.0	9.0	9.0	0.0	65.8

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rand_15_0.8_01	13.0	9.0	11.0	13.0	18.2	3600.1	11.0	11.0	0.0	2.6
rand_15_0.8_02	13.0	9.0	12.0	13.0	8.3	3600.0	12.0	12.0	0.0	1.2
rand_15_0.8_03	13.0	9.0	11.0	13.0	18.2	3600.0	11.0	11.0	0.0	4.7
rand_15_0.8_04	12.0	9.0	10.0	12.0	20.0	3600.0	10.0	10.0	0.0	15.2
rand_15_0.8_05	12.0	8.0	10.0	12.0	20.0	3600.0	10.0	10.0	0.0	2.9
rand_20_0.2_01	8.0	5.0	6.0	8.0	33.3	3600.0	6.0	8.0	33.3	3600.0
rand_20_0.2_02	5.0	3.0	4.0	4.0	0.0	476.5	4.0	5.0	25.0	3600.0
rand_20_0.2_03	7.0	4.0	6.0	7.0	16.7	3600.0	5.0	7.0	40.0	3600.0
rand_20_0.2_04	7.0	5.0	5.0	6.0	20.0	3600.0	5.0	7.0	40.0	3600.0
rand_20_0.2_05	7.0	4.0	6.0	7.0	16.7	3600.0	6.0	7.0	16.7	3600.0
rand_20_0.4_01	13.0	8.0	9.0	12.0	33.3	3600.0	9.0	11.0	22.2	3600.0
rand_20_0.4_02	12.0	6.0	8.0	11.0	37.5	3600.0	9.0	12.0	33.3	3600.0
rand_20_0.4_03	11.0	6.0	8.0	10.0	25.0	3600.0	8.0	10.0	25.0	3600.0
rand_20_0.4_04	11.0	6.0	8.0	9.0	12.5	3600.0	8.0	10.0	25.0	3600.0
rand_20_0.4_05	12.0	8.0	9.0	12.0	33.3	3600.0	9.0	11.0	22.2	3600.0
rand_20_0.6_01	14.0	9.0	10.0	14.0	40.0	3600.0	10.0	12.0	20.0	3600.0
rand_20_0.6_02	14.0	9.0	10.0	14.0	40.0	3600.0	11.0	11.0	0.0	912.6
rand_20_0.6_03	14.0	9.0	10.0	14.0	40.0	3600.0	11.0	12.0	9.1	3600.0
rand_20_0.6_04	13.0	9.0	10.0	13.0	30.0	3600.0	11.0	11.0	0.0	3392.3
rand_20_0.6_05	15.0	8.0	11.0	15.0	36.4	3600.0	12.0	12.0	0.0	925.3
rand_20_0.8_01	18.0	11.0	13.0	18.0	38.5	3600.0	13.0	13.0	0.0	61.2
rand_20_0.8_02	16.0	9.0	12.0	16.0	33.3	3600.0	13.0	13.0	0.0	33.0
rand_20_0.8_03	17.0	8.0	12.0	17.0	41.7	3600.0	13.0	13.0	0.0	38.7
rand_20_0.8_04	18.0	13.0	13.0	18.0	38.5	3600.0	13.0	13.0	0.0	213.6
rand_20_0.8_05	17.0	13.0	14.0	17.0	21.4	3600.0	14.0	14.0	0.0	52.4
rand_25_0.2_01	10.0	6.0	7.0	10.0	42.9	3600.0	7.0	10.0	42.9	3600.0
rand_25_0.2_02	10.0	5.0	7.0	9.0	28.6	3600.0	7.0	10.0	42.9	3600.1
rand_25_0.2_03	9.0	6.0	7.0	8.0	14.3	3600.0	7.0	9.0	28.6	3600.0
rand_25_0.2_04	9.0	5.0	7.0	7.0	0.0	3183.2	7.0	9.0	28.6	3600.0
rand_25_0.2_05	9.0	5.0	6.0	8.0	33.3	3600.0	6.0	9.0	50.0	3600.0
rand_25_0.4_01	11.0	7.0	8.0	11.0	37.5	3600.0	8.0	11.0	37.5	3600.0
rand_25_0.4_02	14.0	6.0	8.0	14.0	75.0	3600.0	8.0	14.0	75.0	3600.0
rand_25_0.4_03	14.0	7.0	9.0	14.0	55.6	3600.0	9.0	14.0	55.6	3600.0
rand_25_0.4_04	14.0	8.0	9.0	14.0	55.6	3600.0	9.0	14.0	55.6	3600.1
rand_25_0.4_05	16.0	7.0	10.0	16.0	60.0	3600.0	10.0	15.0	50.0	3600.0
rand_25_0.6_01	18.0	9.0	11.0	18.0	63.6	3600.1	11.0	15.0	36.4	3600.0
rand_25_0.6_02	18.0	8.0	11.0	18.0	63.6	3600.1	14.0	15.0	7.1	3600.0
rand_25_0.6_03	18.0	9.0	12.0	18.0	50.0	3600.1	13.0	16.0	23.1	3600.1
rand_25_0.6_04	18.0	9.0	13.0	18.0	38.5	3600.1	13.0	16.0	23.1	3600.0
rand_25_0.6_05	18.0	9.0	12.0	18.0	50.0	3600.1	12.0	16.0	33.3	3600.1
rand_25_0.8_01	21.0	13.0	16.0	21.0	31.2	3600.1	16.0	16.0	0.0	2606.0
rand_25_0.8_02	22.0	12.0	15.0	22.0	46.7	3600.1	17.0	17.0	0.0	148.7
rand_25_0.8_03	21.0	15.0	15.0	21.0	40.0	3600.1	17.0	17.0	0.0	1045.6
rand_25_0.8_04	22.0	14.0	15.0	22.0	46.7	3600.1	17.0	17.0	0.0	151.8
rand_25_0.8_05	22.0	13.0	15.0	22.0	46.7	3600.1	16.0	16.0	0.0	941.0

rand_30_0.2_01	10.0	6.0	7.0	10.0	42.9	3600.0	7.0	10.0	42.9	3600.1
rand_30_0.2_02	9.0	5.0	6.0	8.0	33.3	3600.0	6.0	9.0	50.0	3600.1
rand_30_0.2_03	10.0	6.0	7.0	10.0	42.9	3600.0	6.0	10.0	66.7	3600.1
rand_30_0.2_04	10.0	6.0	7.0	9.0	28.6	3600.0	7.0	10.0	42.9	3600.3
rand_30_0.2_05	9.0	6.0	7.0	8.0	14.3	3600.0	7.0	9.0	28.6	3600.2
rand_30_0.4_01	15.0	8.0	9.0	15.0	66.7	3600.1	10.0	15.0	50.0	3600.2
rand_30_0.4_02	16.0	8.0	10.0	16.0	60.0	3600.1	9.0	16.0	77.8	3600.2
rand_30_0.4_03	17.0	8.0	10.0	17.0	70.0	3600.1	10.0	17.0	70.0	3600.1
rand_30_0.4_04	16.0	9.0	9.0	16.0	77.8	3600.1	10.0	16.0	60.0	3600.2
rand_30_0.4_05	16.0	8.0	10.0	16.0	60.0	3600.1	9.0	16.0	77.8	3600.2
rand_30_0.6_01	22.0	9.0	15.0	22.0	46.7	3600.2	14.0	19.0	35.7	3600.1
rand_30_0.6_02	22.0	9.0	15.0	22.0	46.7	3600.2	15.0	19.0	26.7	3600.4
rand_30_0.6_03	21.0	11.0	13.0	21.0	61.5	3600.1	13.0	19.0	46.2	3600.2
rand_30_0.6_04	21.0	9.0	14.0	21.0	50.0	3600.2	14.0	19.0	35.7	3600.1
rand_30_0.6_05	21.0	11.0	12.0	21.0	75.0	3600.2	13.0	19.0	46.2	3600.1
rand_30_0.8_01	25.0	16.0	17.0	25.0	47.1	3600.3	18.0	20.0	11.1	3600.1
rand_30_0.8_02	26.0	17.0	18.0	26.0	44.4	3600.4	18.0	21.0	16.7	3600.1
rand_30_0.8_03	26.0	15.0	19.0	26.0	36.8	3600.4	20.0	20.0	0.0	3407.7
rand_30_0.8_04	26.0	13.0	17.0	26.0	52.9	3600.3	17.0	20.0	17.6	3600.1
rand_30_0.8_05	25.0	15.0	17.0	25.0	47.1	3600.3	19.0	20.0	5.3	3600.1

Table 5: Results using the formulations for the geometric graphs with at most 30 vertices.

			std				**rep**			
instance	cub	h	best	ub	gap	time	best	ub	gap	time
geo_15_0.2_01	6.0	6.0	6.0	6.0	0.0	0.3	6.0	6.0	0.0	0.5
geo_15_0.2_02	5.0	3.0	3.0	3.0	0.0	4.5	3.0	4.0	33.3	3600.0
geo_15_0.2_03	3.0	3.0	3.0	3.0	0.0	0.5	3.0	3.0	0.0	245.2
geo_15_0.2_04	4.0	3.0	3.0	3.0	0.0	3.1	3.0	3.0	0.0	1189.9
geo_15_0.2_05	4.0	3.0	3.0	3.0	0.0	1.4	3.0	3.0	0.0	1422.6
geo_15_0.4_01	8.0	6.0	7.0	7.0	0.0	415.9	7.0	7.0	0.0	2454.0
geo_15_0.4_02	8.0	6.0	7.0	7.0	0.0	1899.9	7.0	8.0	14.3	3600.0
geo_15_0.4_03	6.0	5.0	6.0	6.0	0.0	40.6	6.0	6.0	0.0	204.3
geo_15_0.4_04	8.0	6.0	7.0	8.0	14.3	3600.0	7.0	8.0	14.3	3600.0
geo_15_0.4_05	8.0	7.0	7.0	7.0	0.0	491.7	7.0	8.0	14.3	3600.0
geo_15_0.6_01	12.0	9.0	11.0	12.0	9.1	3600.0	11.0	11.0	0.0	1.9
geo_15_0.6_02	11.0	10.0	11.0	11.0	0.0	68.8	11.0	11.0	0.0	13.1
geo_15_0.6_03	10.0	9.0	10.0	10.0	0.0	189.5	10.0	10.0	0.0	32.0
geo_15_0.6_04	11.0	9.0	10.0	11.0	10.0	3600.0	10.0	11.0	10.0	3600.0
geo_15_0.6_05	10.0	9.0	9.0	10.0	11.1	3600.0	9.0	10.0	11.1	3600.0
geo_15_0.8_01	13.0	12.0	12.0	13.0	8.3	3600.0	12.0	12.0	0.0	0.7
geo_15_0.8_02	13.0	13.0	13.0	13.0	0.0	4.6	13.0	13.0	0.0	0.2
geo_15_0.8_03	12.0	9.0	11.0	12.0	9.1	3600.0	11.0	11.0	0.0	1.7
geo_15_0.8_04	13.0	13.0	13.0	13.0	0.0	4.9	13.0	13.0	0.0	0.2
geo_15_0.8_05	13.0	12.0	13.0	13.0	0.0	16.7	13.0	13.0	0.0	2.1

geo_20_0.2_01	4.0	3.0	3.0	3.0	0.0	25.5	3.0	3.0	0.0	2061.5
geo_20_0.2_02	4.0	4.0	4.0	4.0	0.0	11.2	4.0	6.0	50.0	3600.0
geo_20_0.2_03	6.0	5.0	5.0	5.0	0.0	41.4	4.0	6.0	50.0	3600.0
geo_20_0.2_04	4.0	3.0	3.0	3.0	0.0	79.1	3.0	5.0	66.7	3600.0
geo_20_0.2_05	4.0	3.0	4.0	4.0	0.0	32.2	4.0	4.0	0.0	1539.9
geo_20_0.4_01	11.0	7.0	9.0	11.0	22.2	3600.0	9.0	11.0	22.2	3600.0
geo_20_0.4_02	10.0	8.0	9.0	10.0	11.1	3600.0	9.0	10.0	11.1	3600.0
geo_20_0.4_03	13.0	10.0	11.0	13.0	18.2	3600.0	12.0	13.0	8.3	3600.1
geo_20_0.4_04	10.0	8.0	8.0	10.0	25.0	3600.0	8.0	10.0	25.0	3600.0
geo_20_0.4_05	12.0	8.0	9.0	12.0	33.3	3600.0	10.0	12.0	20.0	3600.0
geo_20_0.6_01	13.0	9.0	11.0	13.0	18.2	3600.1	12.0	13.0	8.3	3600.0
geo_20_0.6_02	15.0	13.0	14.0	15.0	7.1	3600.0	14.0	14.0	0.0	739.0
geo_20_0.6_03	13.0	9.0	12.0	13.0	8.3	3600.1	12.0	13.0	8.3	3600.0
geo_20_0.6_04	12.0	9.0	11.0	12.0	9.1	3600.0	11.0	12.0	9.1	3600.0
geo_20_0.6_05	13.0	10.0	12.0	13.0	8.3	3600.0	12.0	13.0	8.3	3600.0
geo_20_0.8_01	16.0	14.0	15.0	16.0	6.7	3600.0	16.0	16.0	0.0	24.1
geo_20_0.8_02	16.0	15.0	15.0	16.0	6.7	3600.2	16.0	16.0	0.0	85.4
geo_20_0.8_03	17.0	14.0	15.0	17.0	13.3	3600.0	15.0	15.0	0.0	9.8
geo_20_0.8_04	17.0	17.0	17.0	17.0	0.0	32.1	17.0	17.0	0.0	0.6
geo_20_0.8_05	17.0	15.0	16.0	17.0	6.2	3600.0	16.0	16.0	0.0	34.6
geo_25_0.2_01	5.0	4.0	4.0	4.0	0.0	114.3	4.0	6.0	50.0	3600.0
geo_25_0.2_02	5.0	4.0	4.0	4.0	0.0	214.4	4.0	5.0	25.0	3600.4
geo_25_0.2_03	4.0	4.0	4.0	4.0	0.0	46.9	4.0	5.0	25.0	3600.0
geo_25_0.2_04	4.0	3.0	4.0	4.0	0.0	5.5	4.0	6.0	50.0	3600.0
geo_25_0.2_05	7.0	7.0	7.0	7.0	0.0	169.9	7.0	8.0	14.3	3600.0
geo_25_0.4_01	12.0	8.0	9.0	12.0	33.3	3600.0	9.0	12.0	33.3	3600.0
geo_25_0.4_02	11.0	7.0	9.0	11.0	22.2	3600.0	9.0	11.0	22.2	3600.0
geo_25_0.4_03	14.0	11.0	13.0	14.0	7.7	3600.0	12.0	14.0	16.7	3600.1
geo_25_0.4_04	12.0	9.0	10.0	12.0	20.0	3600.0	9.0	12.0	33.3	3600.1
geo_25_0.4_05	14.0	12.0	12.0	14.0	16.7	3600.1	12.0	14.0	16.7	3600.1
geo_25_0.6_01	18.0	17.0	17.0	18.0	5.9	3600.1	17.0	18.0	5.9	3600.1
geo_25_0.6_02	17.0	14.0	15.0	17.0	13.3	3600.1	15.0	17.0	13.3	3600.1
geo_25_0.6_03	18.0	13.0	16.0	18.0	12.5	3600.1	16.0	18.0	12.5	3600.1
geo_25_0.6_04	18.0	14.0	16.0	18.0	12.5	3600.1	15.0	18.0	20.0	3600.0
geo_25_0.6_05	17.0	14.0	15.0	17.0	13.3	3600.0	15.0	17.0	13.3	3600.0
geo_25_0.8_01	20.0	16.0	18.0	20.0	11.1	3600.1	18.0	19.0	5.6	3600.0
geo_25_0.8_02	21.0	18.0	19.0	21.0	10.5	3600.2	20.0	20.0	0.0	1034.5
geo_25_0.8_03	21.0	18.0	20.0	21.0	5.0	3600.1	20.0	20.0	0.0	73.9
geo_25_0.8_04	21.0	19.0	20.0	21.0	5.0	3600.1	20.0	20.0	0.0	108.2
geo_25_0.8_05	21.0	19.0	20.0	21.0	5.0	3600.1	20.0	20.0	0.0	174.7
geo_30_0.2_01	7.0	5.0	6.0	7.0	16.7	3600.2	6.0	7.0	16.7	3600.1
geo_30_0.2_02	6.0	5.0	5.0	5.0	0.0	114.4	4.0	7.0	75.0	3600.1
geo_30_0.2_03	6.0	4.0	5.0	6.0	20.0	3600.0	5.0	6.0	20.0	3600.2
geo_30_0.2_04	8.0	6.0	6.0	7.0	16.7	3600.0	6.0	8.0	33.3	3600.1
geo_30_0.2_05	7.0	5.0	6.0	6.0	0.0	1634.6	6.0	7.0	16.7	3600.1

geo_30_0.4_01	14.0	9.0	12.0	14.0	16.7	3600.0	11.0	14.0	27.3	3600.1
geo_30_0.4_02	13.0	9.0	11.0	13.0	18.2	3600.0	10.0	13.0	30.0	3600.4
geo_30_0.4_03	14.0	9.0	10.0	14.0	40.0	3600.1	10.0	14.0	40.0	3600.1
geo_30_0.4_04	17.0	13.0	15.0	17.0	13.3	3600.1	14.0	17.0	21.4	3600.1
geo_30_0.4_05	18.0	13.0	15.0	18.0	20.0	3600.1	15.0	18.0	20.0	3600.1
geo_30_0.6_01	25.0	20.0	22.0	25.0	13.6	3600.4	21.0	24.0	14.3	3600.1
geo_30_0.6_02	21.0	17.0	18.0	21.0	16.7	3600.2	19.0	21.0	10.5	3600.3
geo_30_0.6_03	23.0	18.0	20.0	23.0	15.0	3600.3	18.0	23.0	27.8	3600.1
geo_30_0.6_04	22.0	17.0	18.0	22.0	22.2	3600.2	18.0	22.0	22.2	3600.1
geo_30_0.6_05	20.0	15.0	16.0	20.0	25.0	3600.2	16.0	20.0	25.0	3600.1
geo_30_0.8_01	25.0	21.0	22.0	25.0	13.6	3600.4	23.0	23.0	0.0	2419.1
geo_30_0.8_02	26.0	24.0	25.0	26.0	4.0	3600.5	25.0	25.0	0.0	1413.7
geo_30_0.8_03	25.0	22.0	24.0	25.0	4.2	3600.3	25.0	25.0	0.0	673.2
geo_30_0.8_04	25.0	21.0	22.0	25.0	13.6	3600.4	23.0	23.0	0.0	2888.7
geo_30_0.8_05	24.0	20.0	21.0	24.0	14.3	3601.1	21.0	23.0	9.5	3600.0

Table 6: Results using the formulations for the complement of bipartite graphs with at most 30 vertices.

			std				**rep**			
instance	cub	h	best	ub	gap	time	best	ub	gap	time
cbip_15_0.2_01	13.0	10.0	11.0	13.0	18.2	3600.0	11.0	11.0	0.0	7.3
cbip_15_0.2_02	13.0	9.0	10.0	13.0	30.0	3600.0	10.0	10.0	0.0	6.6
cbip_15_0.2_03	12.0	9.0	11.0	12.0	9.1	3600.0	11.0	11.0	0.0	94.9
cbip_15_0.2_04	13.0	10.0	11.0	13.0	18.2	3600.0	11.0	11.0	0.0	5.1
cbip_15_0.2_05	12.0	9.0	11.0	12.0	9.1	3600.0	11.0	11.0	0.0	60.3
cbip_15_0.4_01	11.0	10.0	10.0	11.0	10.0	3600.0	10.0	11.0	10.0	3600.0
cbip_15_0.4_02	10.0	9.0	10.0	10.0	0.0	114.6	10.0	10.0	0.0	262.3
cbip_15_0.4_03	10.0	8.0	9.0	10.0	11.1	3600.0	9.0	10.0	11.1	3600.0
cbip_15_0.4_04	10.0	8.0	9.0	10.0	11.1	3600.0	9.0	10.0	11.1	3600.0
cbip_15_0.4_05	10.0	9.0	9.0	10.0	11.1	3600.0	9.0	10.0	11.1	3600.0
cbip_15_0.6_01	9.0	9.0	9.0	9.0	0.0	0.7	9.0	9.0	0.0	0.5
cbip_15_0.6_02	10.0	10.0	10.0	10.0	0.0	1.7	10.0	10.0	0.0	0.4
cbip_15_0.6_03	9.0	9.0	9.0	9.0	0.0	0.7	9.0	9.0	0.0	0.5
cbip_15_0.6_04	9.0	9.0	9.0	9.0	0.0	0.7	9.0	9.0	0.0	1.6
cbip_15_0.6_05	9.0	9.0	9.0	9.0	0.0	0.7	9.0	9.0	0.0	0.5
cbip_15_0.8_01	10.0	10.0	10.0	10.0	0.0	1.7	10.0	10.0	0.0	0.5
cbip_15_0.8_02	8.0	8.0	8.0	8.0	0.0	0.6	8.0	8.0	0.0	0.5
cbip_15_0.8_03	8.0	8.0	8.0	8.0	0.0	0.6	8.0	8.0	0.0	0.6
cbip_15_0.8_04	8.0	8.0	8.0	8.0	0.0	0.6	8.0	8.0	0.0	0.5
cbip_15_0.8_05	9.0	9.0	9.0	9.0	0.0	0.7	9.0	9.0	0.0	0.5
cbip_20_0.2_01	17.0	13.0	14.0	17.0	21.4	3600.1	14.0	14.0	0.0	131.8
cbip_20_0.2_02	18.0	12.0	14.0	18.0	28.6	3600.0	14.0	14.0	0.0	27.4
cbip_20_0.2_03	18.0	13.0	14.0	18.0	28.6	3600.0	14.0	14.0	0.0	67.5
cbip_20_0.2_04	17.0	13.0	14.0	17.0	21.4	3600.0	14.0	14.0	0.0	58.4

cbip_20_0.2_05	17.0	12.0	13.0	17.0	30.8	3600.0	14.0	14.0	0.0	473.9
cbip_20_0.4_01	13.0	11.0	12.0	13.0	8.3	3600.1	12.0	13.0	8.3	3600.0
cbip_20_0.4_02	15.0	11.0	12.0	15.0	25.0	3600.0	12.0	14.0	16.7	3600.0
cbip_20_0.4_03	14.0	11.0	12.0	14.0	16.7	3600.0	12.0	14.0	16.7	3600.0
cbip_20_0.4_04	15.0	14.0	14.0	15.0	7.1	3600.0	14.0	15.0	7.1	3600.0
cbip_20_0.4_05	14.0	11.0	12.0	14.0	16.7	3600.0	12.0	14.0	16.7	3600.0
cbip_20_0.6_01	10.0	10.0	10.0	10.0	0.0	95.8	10.0	11.0	10.0	3600.0
cbip_20_0.6_02	11.0	11.0	11.0	11.0	0.0	5.6	11.0	11.0	0.0	3.2
cbip_20_0.6_03	12.0	12.0	12.0	12.0	0.0	6.7	12.0	12.0	0.0	3.4
cbip_20_0.6_04	12.0	12.0	12.0	12.0	0.0	6.7	12.0	12.0	0.0	3.2
cbip_20_0.6_05	11.0	11.0	11.0	11.0	0.0	5.6	11.0	11.0	0.0	3.3
cbip_20_0.8_01	10.0	10.0	10.0	10.0	0.0	219.6	10.0	11.0	10.0	3600.0
cbip_20_0.8_02	14.0	14.0	14.0	14.0	0.0	10.3	14.0	14.0	0.0	2.7
cbip_20_0.8_03	13.0	13.0	13.0	13.0	0.0	8.3	13.0	13.0	0.0	2.9
cbip_20_0.8_04	11.0	11.0	11.0	11.0	0.0	5.4	11.0	11.0	0.0	3.2
cbip_20_0.8_05	11.0	11.0	11.0	11.0	0.0	5.6	11.0	11.0	0.0	3.3
cbip_25_0.2_01	22.0	17.0	17.0	22.0	29.4	3600.1	18.0	18.0	0.0	833.8
cbip_25_0.2_02	21.0	14.0	15.0	21.0	40.0	3600.1	16.0	18.0	12.5	3600.0
cbip_25_0.2_03	21.0	15.0	17.0	21.0	23.5	3600.1	17.0	17.0	0.0	2797.5
cbip_25_0.2_04	22.0	15.0	16.0	22.0	37.5	3600.1	17.0	17.0	0.0	1590.8
cbip_25_0.2_05	21.0	17.0	17.0	21.0	23.5	3600.1	18.0	20.0	11.1	3600.0
cbip_25_0.4_01	18.0	15.0	15.0	18.0	20.0	3600.1	16.0	18.0	12.5	3600.0
cbip_25_0.4_02	17.0	13.0	14.0	17.0	21.4	3600.1	14.0	17.0	21.4	3600.1
cbip_25_0.4_03	18.0	14.0	14.0	18.0	28.6	3600.1	14.0	18.0	28.6	3600.1
cbip_25_0.4_04	19.0	17.0	17.0	19.0	11.8	3600.1	17.0	19.0	11.8	3600.1
cbip_25_0.4_05	17.0	14.0	14.0	17.0	21.4	3600.0	14.0	17.0	21.4	3600.1
cbip_25_0.6_01	13.0	13.0	13.0	13.0	0.0	5.8	13.0	13.0	0.0	12.2
cbip_25_0.6_02	18.0	18.0	18.0	18.0	0.0	12.0	18.0	18.0	0.0	10.4
cbip_25_0.6_03	14.0	14.0	14.0	14.0	0.0	6.1	14.0	14.0	0.0	11.1
cbip_25_0.6_04	15.0	15.0	15.0	15.0	0.0	6.8	15.0	15.0	0.0	11.4
cbip_25_0.6_05	15.0	15.0	15.0	15.0	0.0	6.2	15.0	15.0	0.0	11.5
cbip_25_0.8_01	13.0	13.0	13.0	13.0	0.0	5.3	13.0	13.0	0.0	12.0
cbip_25_0.8_02	14.0	14.0	14.0	14.0	0.0	5.4	14.0	14.0	0.0	11.4
cbip_25_0.8_03	13.0	13.0	13.0	13.0	0.0	5.2	13.0	13.0	0.0	11.9
cbip_25_0.8_04	14.0	14.0	14.0	14.0	0.0	6.0	14.0	14.0	0.0	11.7
cbip_25_0.8_05	16.0	16.0	16.0	16.0	0.0	8.9	16.0	16.0	0.0	10.2
cbip_30_0.2_01	27.0	23.0	23.0	27.0	17.4	3600.4	23.0	23.0	0.0	3296.1
cbip_30_0.2_02	26.0	19.0	19.0	26.0	36.8	3600.4	19.0	22.0	15.8	3600.1
cbip_30_0.2_03	26.0	16.0	19.0	26.0	36.8	3600.3	19.0	21.0	10.5	3600.0
cbip_30_0.2_04	25.0	17.0	18.0	25.0	38.9	3600.3	19.0	22.0	15.8	3600.1
cbip_30_0.2_05	27.0	22.0	22.0	27.0	22.7	3600.8	23.0	23.0	0.0	2430.6
cbip_30_0.4_01	21.0	16.0	17.0	21.0	23.5	3600.2	16.0	21.0	31.2	3600.1
cbip_30_0.4_02	22.0	20.0	20.0	22.0	10.0	3600.3	20.0	22.0	10.0	3600.2
cbip_30_0.4_03	23.0	22.0	22.0	23.0	4.5	3600.3	22.0	23.0	4.5	3600.1
cbip_30_0.4_04	24.0	24.0	24.0	24.0	0.0	118.6	24.0	24.0	0.0	37.2

cbip_30_0.4_05	20.0	16.0	17.0	20.0	17.6	3600.1	17.0	20.0	17.6	3600.1
cbip_30_0.6_01	19.0	19.0	19.0	19.0	0.0	61.2	19.0	19.0	0.0	30.6
cbip_30_0.6_02	16.0	16.0	16.0	16.0	0.0	38.6	16.0	16.0	0.0	56.5
cbip_30_0.6_03	16.0	16.0	16.0	16.0	0.0	38.8	16.0	16.0	0.0	45.7
cbip_30_0.6_04	16.0	16.0	16.0	16.0	0.0	39.1	16.0	16.0	0.0	45.1
cbip_30_0.6_05	16.0	16.0	16.0	16.0	0.0	40.1	16.0	16.0	0.0	44.1
cbip_30_0.8_01	16.0	16.0	16.0	16.0	0.0	40.6	16.0	16.0	0.0	34.9
cbip_30_0.8_02	15.0	15.0	15.0	16.0	6.7	3600.1	15.0	16.0	6.7	3600.1
cbip_30_0.8_03	15.0	15.0	15.0	16.0	6.7	3600.2	15.0	16.0	6.7	3600.1
cbip_30_0.8_04	17.0	17.0	17.0	17.0	0.0	48.4	17.0	17.0	0.0	33.7
cbip_30_0.8_05	18.0	18.0	18.0	18.0	0.0	46.1	18.0	18.0	0.0	31.6

Appendix B BRKGA results for the connected Grundy coloring problem

Table 7: BRKGA-G and BRKGA+R+LS results for the random graphs.

	BRKGA-G			**BRKGA+R+LS**				
instance	mean	max	ttb	mean	max	ttb	$diff_{Mean}$	$diff_{Max}$
rand_50_0.2_01	10.98	11.00	43.1	11.00	11.00	12.4	0.18	0.00
rand_50_0.2_02	11.08	12.00	6.6	11.18	12.00	22.2	0.90	0.00
rand_50_0.2_03	11.00	11.00	11.4	11.02	12.00	9.1	0.18	9.09
rand_50_0.2_04	10.94	11.00	38.7	11.00	11.00	18.3	0.55	0.00
rand_50_0.2_05	11.64	13.00	56.5	11.98	12.00	59.1	2.92	-7.69
rand_50_0.4_01	16.20	17.00	49.9	16.44	17.00	65.9	1.48	0.00
rand_50_0.4_02	16.28	18.00	69.1	16.60	17.00	75.0	1.97	-5.56
rand_50_0.4_03	16.08	17.00	25.3	16.50	17.00	97.5	2.61	0.00
rand_50_0.4_04	16.36	17.00	43.8	16.86	18.00	81.4	3.06	5.88
rand_50_0.4_05	16.10	17.00	26.9	16.44	17.00	80.6	2.11	0.00
rand_50_0.6_01	22.98	24.00	46.8	23.20	24.00	59.5	0.96	0.00
rand_50_0.6_02	22.08	23.00	61.0	22.52	23.00	73.8	1.99	0.00
rand_50_0.6_03	22.58	23.00	60.3	23.06	24.00	90.5	2.13	4.35
rand_50_0.6_04	22.28	23.00	60.6	22.66	23.00	89.1	1.71	0.00
rand_50_0.6_05	23.34	24.00	58.2	23.74	24.00	77.6	1.71	0.00
rand_50_0.8_01	31.62	32.00	61.3	31.82	32.00	79.8	0.63	0.00
rand_50_0.8_02	29.80	31.00	31.8	30.12	31.00	56.1	1.07	0.00
rand_50_0.8_03	30.02	31.00	61.7	30.10	31.00	49.5	0.27	0.00
rand_50_0.8_04	31.44	32.00	56.6	31.56	32.00	71.8	0.38	0.00
rand_50_0.8_05	30.74	31.00	55.5	30.92	31.00	56.5	0.59	0.00
rand_60_0.2_01	12.84	13.00	65.1	13.00	13.00	46.1	1.25	0.00
rand_60_0.2_02	12.42	13.00	42.6	12.62	13.00	64.5	1.61	0.00
rand_60_0.2_03	11.96	12.00	22.2	12.00	12.00	11.9	0.33	0.00
rand_60_0.2_04	12.02	13.00	19.2	12.00	12.00	8.2	-0.17	-7.69
rand_60_0.2_05	11.48	12.00	53.2	11.98	12.00	90.0	4.36	0.00
rand_60_0.4_01	19.18	20.00	28.5	19.50	20.00	76.8	1.67	0.00
rand_60_0.4_02	19.24	20.00	49.3	19.38	20.00	65.3	0.73	0.00
rand_60_0.4_03	18.30	20.00	60.5	18.74	19.00	100.1	2.40	-5.00
rand_60_0.4_04	18.78	19.00	63.7	19.02	20.00	99.0	1.28	5.26
rand_60_0.4_05	19.20	20.00	77.5	19.48	20.00	79.0	1.46	0.00
rand_60_0.6_01	25.46	26.00	68.8	25.82	27.00	101.2	1.41	3.85
rand_60_0.6_02	25.80	27.00	57.9	26.22	27.00	94.7	1.63	0.00
rand_60_0.6_03	26.54	28.00	60.7	26.90	28.00	103.5	1.36	0.00
rand_60_0.6_04	25.66	27.00	67.1	26.16	27.00	83.5	1.95	0.00
rand_60_0.6_05	25.04	26.00	69.1	25.32	26.00	73.3	1.12	0.00
rand_60_0.8_01	34.80	36.00	75.0	34.94	36.00	84.0	0.40	0.00
rand_60_0.8_02	35.20	36.00	65.0	35.40	36.00	85.9	0.57	0.00
rand_60_0.8_03	36.92	37.00	60.6	37.02	38.00	61.6	0.27	2.70

rand_60_0.8_04	36.04	37.00	47.9	36.28	37.00	90.2	0.67	0.00
rand_60_0.8_05	35.12	36.00	46.8	35.42	36.00	79.7	0.85	0.00
rand_70_0.2_01	13.26	14.00	25.8	13.42	14.00	68.8	1.21	0.00
rand_70_0.2_02	13.58	14.00	50.5	13.72	14.00	95.3	1.03	0.00
rand_70_0.2_03	13.00	13.00	11.0	13.06	14.00	17.0	0.46	7.69
rand_70_0.2_04	12.98	13.00	15.9	13.02	14.00	16.7	0.31	7.69
rand_70_0.2_05	13.38	14.00	25.9	13.94	14.00	86.8	4.19	0.00
rand_70_0.4_01	20.36	21.00	54.3	20.56	22.00	82.8	0.98	4.76
rand_70_0.4_02	21.12	22.00	45.9	21.36	22.00	81.7	1.14	0.00
rand_70_0.4_03	20.96	22.00	64.0	21.14	22.00	69.1	0.86	0.00
rand_70_0.4_04	20.96	22.00	56.7	21.26	22.00	87.0	1.43	0.00
rand_70_0.4_05	21.20	22.00	38.6	21.38	22.00	84.8	0.85	0.00
rand_70_0.6_01	27.78	29.00	66.3	28.22	29.00	120.9	1.58	0.00
rand_70_0.6_02	28.20	29.00	37.3	28.58	30.00	112.6	1.35	3.45
rand_70_0.6_03	28.24	29.00	66.9	28.56	30.00	82.2	1.13	3.45
rand_70_0.6_04	28.60	30.00	78.3	28.66	30.00	113.9	0.21	0.00
rand_70_0.6_05	28.38	29.00	79.3	28.66	30.00	95.8	0.99	3.45
rand_70_0.8_01	40.24	41.00	54.9	40.22	41.00	120.5	-0.05	0.00
rand_70_0.8_02	39.78	41.00	38.3	40.02	41.00	112.2	0.60	0.00
rand_70_0.8_03	38.94	40.00	74.2	38.90	41.00	88.7	-0.10	2.50
rand_70_0.8_04	39.76	41.00	55.7	39.88	41.00	103.5	0.30	0.00
rand_70_0.8_05	38.58	40.00	49.7	38.94	40.00	106.0	0.93	0.00
rand_80_0.2_01	14.38	15.00	25.5	14.70	15.00	93.6	2.23	0.00
rand_80_0.2_02	14.56	15.00	60.5	14.80	15.00	97.9	1.65	0.00
rand_80_0.2_03	14.62	15.00	46.0	14.86	16.00	101.2	1.64	6.67
rand_80_0.2_04	13.76	14.00	43.0	13.94	14.00	66.0	1.31	0.00
rand_80_0.2_05	14.78	16.00	38.7	14.98	15.00	70.9	1.35	-6.25
rand_80_0.4_01	23.02	24.00	43.6	23.08	24.00	86.5	0.26	0.00
rand_80_0.4_02	22.50	24.00	57.9	22.42	23.00	90.0	-0.36	-4.17
rand_80_0.4_03	22.38	23.00	53.0	22.42	24.00	73.1	0.18	4.35
rand_80_0.4_04	22.20	23.00	52.4	22.36	23.00	88.1	0.72	0.00
rand_80_0.4_05	22.82	24.00	57.8	22.94	24.00	99.8	0.53	0.00
rand_80_0.6_01	31.22	32.00	56.8	31.52	33.00	102.6	0.96	3.12
rand_80_0.6_02	31.48	33.00	52.5	31.68	33.00	112.4	0.64	0.00
rand_80_0.6_03	31.08	32.00	70.1	31.14	32.00	99.7	0.19	0.00
rand_80_0.6_04	32.32	33.00	65.6	32.24	34.00	108.7	-0.25	3.03
rand_80_0.6_05	32.16	34.00	83.0	32.06	33.00	92.5	-0.31	-2.94
rand_80_0.8_01	44.18	46.00	65.5	44.06	46.00	130.7	-0.27	0.00
rand_80_0.8_02	43.44	45.00	67.4	43.46	45.00	99.2	0.05	0.00
rand_80_0.8_03	42.50	44.00	44.7	42.48	44.00	110.8	-0.05	0.00
rand_80_0.8_04	43.02	44.00	58.4	43.16	45.00	127.9	0.33	2.27
rand_80_0.8_05	43.66	45.00	86.8	43.50	45.00	95.5	-0.37	0.00

Table 8: BRKGA-G and BRKGA+R+LS results for the geometric graphs.

	BRKGA-G			**BRKGA+R+LS**				
instance	mean	max	ttb	mean	max	ttb	$diff_{Mean}$	$diff_{Max}$
geo_50_0.2_01	8.00	8.00	0.0	8.00	8.00	0.0	0.00	0.00
geo_50_0.2_02	9.00	9.00	0.0	9.00	9.00	0.0	0.00	0.00
geo_50_0.2_03	8.00	8.00	0.0	8.00	8.00	0.0	0.00	0.00
geo_50_0.2_04	9.00	9.00	0.0	9.00	9.00	0.0	0.00	0.00
geo_50_0.2_05	8.00	8.00	0.0	8.00	8.00	0.0	0.00	0.00
geo_50_0.4_01	25.92	26.00	34.5	26.00	26.00	34.3	0.31	0.00
geo_50_0.4_02	19.00	19.00	0.0	19.00	19.00	0.1	0.00	0.00
geo_50_0.4_03	19.92	20.00	19.0	20.00	20.00	8.2	0.40	0.00
geo_50_0.4_04	22.24	23.00	90.4	22.30	23.00	95.2	0.27	0.00
geo_50_0.4_05	22.98	23.00	16.4	23.00	23.00	14.0	0.09	0.00
geo_50_0.6_01	27.20	28.00	30.6	27.14	28.00	13.6	-0.22	0.00
geo_50_0.6_02	32.72	33.00	46.1	32.94	33.00	77.5	0.67	0.00
geo_50_0.6_03	33.00	33.00	0.1	33.00	33.00	0.6	0.00	0.00
geo_50_0.6_04	30.84	31.00	43.9	30.96	31.00	45.9	0.39	0.00
geo_50_0.6_05	31.00	31.00	14.8	31.00	31.00	11.9	0.00	0.00
geo_50_0.8_01	40.00	40.00	0.9	40.00	40.00	1.7	0.00	0.00
geo_50_0.8_02	35.96	36.00	6.1	36.00	36.00	6.4	0.11	0.00
geo_50_0.8_03	40.00	40.00	0.0	40.00	40.00	0.5	0.00	0.00
geo_50_0.8_04	37.00	37.00	0.3	37.00	37.00	2.1	0.00	0.00
geo_50_0.8_05	36.00	36.00	3.6	36.00	36.00	8.5	0.00	0.00
geo_60_0.2_01	9.00	9.00	0.0	9.00	9.00	0.0	0.00	0.00
geo_60_0.2_02	8.48	9.00	35.6	9.00	9.00	53.1	6.13	0.00
geo_60_0.2_03	10.52	11.00	20.0	11.00	11.00	10.3	4.56	0.00
geo_60_0.2_04	9.00	9.00	0.1	9.00	9.00	0.1	0.00	0.00
geo_60_0.2_05	11.00	11.00	0.0	11.00	11.00	0.0	0.00	0.00
geo_60_0.4_01	25.90	27.00	92.8	25.98	27.00	49.6	0.31	0.00
geo_60_0.4_02	27.86	28.00	29.5	27.98	29.00	42.3	0.43	3.57
geo_60_0.4_03	24.98	25.00	26.7	25.00	25.00	16.1	0.08	0.00
geo_60_0.4_04	25.64	26.00	87.8	25.56	26.00	83.0	-0.31	0.00
geo_60_0.4_05	26.40	28.00	18.2	26.44	28.00	26.5	0.15	0.00
geo_60_0.6_01	38.40	39.00	41.3	38.34	39.00	49.3	-0.16	0.00
geo_60_0.6_02	39.04	40.00	9.8	39.08	40.00	19.0	0.10	0.00
geo_60_0.6_03	33.02	34.00	20.0	33.06	34.00	31.0	0.12	0.00
geo_60_0.6_04	38.90	39.00	27.1	38.92	39.00	47.6	0.05	0.00
geo_60_0.6_05	37.88	38.00	42.2	37.92	38.00	64.8	0.11	0.00
geo_60_0.8_01	49.00	49.00	0.1	49.00	49.00	1.6	0.00	0.00
geo_60_0.8_02	46.00	46.00	0.2	46.00	46.00	4.7	0.00	0.00
geo_60_0.8_03	45.78	46.00	34.1	45.88	46.00	60.5	0.22	0.00
geo_60_0.8_04	47.92	48.00	12.5	48.00	48.00	22.2	0.17	0.00
geo_60_0.8_05	47.98	48.00	1.9	48.00	48.00	13.7	0.04	0.00
geo_70_0.2_01	11.00	11.00	0.0	11.00	11.00	0.2	0.00	0.00
geo_70_0.2_02	12.00	12.00	2.1	12.00	12.00	1.5	0.00	0.00

geo_70_0.2_03	11.46	12.00	25.3	12.00	12.00	69.8	4.71	0.00
geo_70_0.2_04	13.00	13.00	0.1	13.00	13.00	0.1	0.00	0.00
geo_70_0.2_05	12.00	12.00	0.0	12.00	12.00	0.0	0.00	0.00
geo_70_0.4_01	25.28	27.00	41.0	25.44	28.00	27.4	0.63	3.70
geo_70_0.4_02	28.60	30.00	94.3	28.78	30.00	115.2	0.63	0.00
geo_70_0.4_03	25.00	25.00	1.0	25.10	26.00	9.8	0.40	4.00
geo_70_0.4_04	28.98	30.00	37.8	28.90	30.00	54.7	-0.28	0.00
geo_70_0.4_05	26.40	27.00	67.0	26.74	27.00	76.6	1.29	0.00
geo_70_0.6_01	37.06	38.00	39.7	37.06	38.00	73.5	0.00	0.00
geo_70_0.6_02	43.92	44.00	69.4	43.78	44.00	87.1	-0.32	0.00
geo_70_0.6_03	42.90	44.00	35.0	42.82	43.00	74.9	-0.19	-2.27
geo_70_0.6_04	40.44	42.00	93.4	40.44	42.00	94.7	0.00	0.00
geo_70_0.6_05	42.70	43.00	46.6	42.66	43.00	75.4	-0.09	0.00
geo_70_0.8_01	58.86	59.00	38.6	58.86	59.00	38.5	0.00	0.00
geo_70_0.8_02	54.76	55.00	35.7	54.86	55.00	37.7	0.18	0.00
geo_70_0.8_03	52.30	53.00	21.4	52.28	53.00	55.3	-0.04	0.00
geo_70_0.8_04	51.38	52.00	40.0	51.26	52.00	48.3	-0.23	0.00
geo_70_0.8_05	51.02	52.00	12.0	51.12	52.00	23.2	0.20	0.00
geo_80_0.2_02	11.00	11.00	0.3	11.00	11.00	0.9	0.00	0.00
geo_80_0.2_03	11.00	11.00	0.0	11.00	11.00	0.0	0.00	0.00
geo_80_0.2_04	14.00	14.00	0.2	14.00	14.00	0.2	0.00	0.00
geo_80_0.2_05	12.00	12.00	0.0	12.00	12.00	0.0	0.00	0.00
geo_80_0.4_01	31.74	32.00	52.6	31.54	32.00	60.8	-0.63	0.00
geo_80_0.4_02	34.98	36.00	42.7	34.60	35.00	75.3	-1.09	-2.78
geo_80_0.4_03	28.06	29.00	128.9	27.62	29.00	124.7	-1.57	0.00
geo_80_0.4_04	31.22	32.00	17.1	31.36	33.00	48.4	0.45	3.12
geo_80_0.4_05	30.76	32.00	22.8	30.44	32.00	55.0	-1.04	0.00
geo_80_0.6_01	46.08	47.00	39.9	45.86	47.00	87.8	-0.48	0.00
geo_80_0.6_02	45.80	47.00	75.4	45.18	46.00	95.5	-1.35	-2.13
geo_80_0.6_03	51.26	52.00	44.6	51.00	52.00	19.7	-0.51	0.00
geo_80_0.6_04	47.98	49.00	24.4	47.94	49.00	60.6	-0.08	0.00
geo_80_0.6_05	46.90	47.00	41.9	46.88	47.00	66.1	-0.04	0.00
geo_80_0.8_01	63.98	64.00	2.4	63.96	64.00	29.5	-0.03	0.00
geo_80_0.8_02	59.66	60.00	31.5	59.58	60.00	58.9	-0.13	0.00
geo_80_0.8_03	63.00	63.00	0.4	63.00	63.00	6.3	0.00	0.00
geo_80_0.8_04	60.96	61.00	5.8	60.96	61.00	27.1	0.00	0.00
geo_80_0.8_05	64.00	64.00	0.5	64.00	64.00	8.0	0.00	0.00

Table 9: BRKGA-G and BRKGA+R+LS results for the complement of bipartite graphs.

	BRKGA-G			**BRKGA+R+LS**				
instance	mean	max	ttb	mean	max	ttb	$diff_{Mean}$	$diff_{Max}$
cbip_50_0.2_01	34.98	35.00	2.7	35.00	35.00	3.4	0.06	0.00
cbip_50_0.2_02	34.00	34.00	0.1	34.00	34.00	0.5	0.00	0.00
cbip_50_0.2_03	33.96	34.00	6.0	34.00	34.00	13.9	0.12	0.00

cbip_50_0.2_04	33.86	34.00	9.9	34.00	34.00	19.0	0.41	0.00
cbip_50_0.2_05	35.90	36.00	44.0	36.00	36.00	14.6	0.28	0.00
cbip_50_0.4_01	30.50	31.00	0.6	30.88	31.00	47.0	1.25	0.00
cbip_50_0.4_02	30.96	31.00	7.8	31.00	31.00	2.2	0.13	0.00
cbip_50_0.4_03	31.92	32.00	3.6	32.00	32.00	12.3	0.25	0.00
cbip_50_0.4_04	30.86	31.00	5.3	30.96	31.00	21.9	0.32	0.00
cbip_50_0.4_05	30.90	31.00	0.1	30.96	31.00	9.2	0.19	0.00
cbip_50_0.6_01	29.90	30.00	1.4	30.00	30.00	12.4	0.33	0.00
cbip_50_0.6_02	29.00	29.00	0.0	29.00	29.00	0.4	0.00	0.00
cbip_50_0.6_03	29.00	29.00	5.1	29.00	29.00	1.1	0.00	0.00
cbip_50_0.6_04	29.00	29.00	0.0	29.00	29.00	0.2	0.00	0.00
cbip_50_0.6_05	29.00	29.00	0.5	29.00	29.00	0.2	0.00	0.00
cbip_50_0.8_01	28.00	28.00	0.1	28.00	28.00	0.2	0.00	0.00
cbip_50_0.8_02	35.00	35.00	0.0	35.00	35.00	0.1	0.00	0.00
cbip_50_0.8_03	34.00	34.00	0.0	34.00	34.00	0.1	0.00	0.00
cbip_50_0.8_04	28.00	28.00	11.9	28.00	28.00	3.4	0.00	0.00
cbip_50_0.8_05	27.00	27.00	0.0	27.00	27.00	0.1	0.00	0.00
cbip_60_0.2_01	40.92	41.00	0.7	40.98	41.00	10.9	0.15	0.00
cbip_60_0.2_02	40.60	41.00	12.9	40.78	41.00	37.0	0.44	0.00
cbip_60_0.2_03	43.00	43.00	0.5	43.00	43.00	2.4	0.00	0.00
cbip_60_0.2_04	40.90	41.00	1.2	41.00	41.00	23.5	0.24	0.00
cbip_60_0.2_05	40.24	41.00	9.3	40.48	41.00	36.7	0.60	0.00
cbip_60_0.4_01	39.00	39.00	11.0	39.00	39.00	10.3	0.00	0.00
cbip_60_0.4_02	39.84	40.00	3.8	39.70	40.00	6.3	-0.35	0.00
cbip_60_0.4_03	35.96	36.00	6.9	36.00	36.00	9.3	0.11	0.00
cbip_60_0.4_04	36.32	37.00	17.5	36.50	37.00	58.0	0.50	0.00
cbip_60_0.4_05	38.00	38.00	0.4	38.00	38.00	1.9	0.00	0.00
cbip_60_0.6_01	34.18	35.00	0.2	34.42	35.00	30.2	0.70	0.00
cbip_60_0.6_02	39.00	39.00	0.0	39.00	39.00	0.2	0.00	0.00
cbip_60_0.6_03	34.00	34.00	0.1	34.00	34.00	0.8	0.00	0.00
cbip_60_0.6_04	34.82	35.00	9.2	35.00	35.00	48.7	0.52	0.00
cbip_60_0.6_05	34.28	35.00	7.2	34.64	35.00	73.5	1.05	0.00
cbip_60_0.8_01	32.60	33.00	42.4	32.88	33.00	66.3	0.86	0.00
cbip_60_0.8_02	40.00	40.00	0.0	40.00	40.00	0.2	0.00	0.00
cbip_60_0.8_03	32.96	33.00	21.2	33.00	33.00	7.8	0.12	0.00
cbip_60_0.8_04	34.00	34.00	4.2	34.00	34.00	3.9	0.00	0.00
cbip_60_0.8_05	32.98	33.00	24.8	33.00	33.00	9.9	0.06	0.00
cbip_70_0.2_01	47.82	48.00	0.7	47.92	48.00	20.5	0.21	0.00
cbip_70_0.2_02	45.26	46.00	0.8	45.46	46.00	25.6	0.44	0.00
cbip_70_0.2_03	45.22	46.00	1.2	45.34	46.00	34.3	0.27	0.00
cbip_70_0.2_04	50.00	50.00	2.2	50.00	50.00	5.5	0.00	0.00
cbip_70_0.2_05	45.76	46.00	5.5	45.98	46.00	28.5	0.48	0.00
cbip_70_0.4_01	41.80	42.00	1.5	41.76	42.00	31.5	-0.10	0.00
cbip_70_0.4_02	46.68	47.00	47.6	46.72	47.00	52.4	0.09	0.00
cbip_70_0.4_03	47.00	47.00	12.8	47.00	47.00	16.9	0.00	0.00

cbip_70_0.4_04	44.40	45.00	9.8	44.30	45.00	16.9	-0.23	0.00
cbip_70_0.4_05	42.42	43.00	0.6	42.32	43.00	9.6	-0.24	0.00
cbip_70_0.6_01	40.00	40.00	0.3	40.00	40.00	1.3	0.00	0.00
cbip_70_0.6_02	39.82	40.00	1.6	39.92	40.00	17.9	0.25	0.00
cbip_70_0.6_03	45.00	45.00	0.0	45.00	45.00	0.5	0.00	0.00
cbip_70_0.6_04	40.00	40.00	0.3	40.00	40.00	1.5	0.00	0.00
cbip_70_0.6_05	43.80	44.00	84.3	43.68	44.00	109.1	-0.27	0.00
cbip_70_0.8_01	38.80	39.00	4.7	38.84	39.00	42.0	0.10	0.00
cbip_70_0.8_02	39.00	39.00	2.7	39.00	39.00	3.7	0.00	0.00
cbip_70_0.8_03	45.00	45.00	0.0	45.00	45.00	0.4	0.00	0.00
cbip_70_0.8_04	45.00	45.00	0.0	45.00	45.00	0.4	0.00	0.00
cbip_70_0.8_05	38.00	38.00	0.2	38.00	38.00	0.8	0.00	0.00
cbip_80_0.2_01	51.72	52.00	0.8	51.68	52.00	32.0	-0.08	0.00
cbip_80_0.2_02	52.42	53.00	18.9	52.40	53.00	48.5	-0.04	0.00
cbip_80_0.2_03	46.86	47.00	2.8	46.90	47.00	20.3	0.09	0.00
cbip_80_0.2_04	52.86	53.00	0.7	52.78	53.00	24.8	-0.15	0.00
cbip_80_0.2_05	52.04	53.00	0.5	52.08	53.00	23.5	0.08	0.00
cbip_80_0.4_01	47.68	48.00	6.3	47.64	48.00	36.0	-0.08	0.00
cbip_80_0.4_02	46.98	47.00	5.0	46.94	47.00	19.9	-0.09	0.00
cbip_80_0.4_03	47.22	48.00	9.6	47.08	48.00	33.3	-0.30	0.00
cbip_80_0.4_04	46.98	47.00	3.7	46.92	47.00	8.5	-0.13	0.00
cbip_80_0.4_05	46.98	47.00	0.7	46.96	47.00	19.7	-0.04	0.00
cbip_80_0.6_01	45.62	46.00	2.5	45.68	46.00	11.3	0.13	0.00
cbip_80_0.6_02	45.42	46.00	1.3	45.40	46.00	4.9	-0.04	0.00
cbip_80_0.6_03	50.00	50.00	0.0	50.00	50.00	0.8	0.00	0.00
cbip_80_0.6_04	45.00	45.00	0.7	44.98	45.00	6.9	-0.04	0.00
cbip_80_0.6_05	45.00	45.00	0.3	44.98	45.00	12.8	-0.04	0.00
cbip_80_0.8_01	43.00	43.00	4.6	43.00	43.00	2.3	0.00	0.00
cbip_80_0.8_02	43.00	43.00	0.3	43.00	43.00	1.7	0.00	0.00
cbip_80_0.8_03	49.00	49.00	0.0	49.00	49.00	0.7	0.00	0.00
cbip_80_0.8_04	44.00	44.00	1.3	44.00	44.00	2.4	0.00	0.00
cbip_80_0.8_05	44.64	45.00	88.4	44.58	45.00	84.2	-0.13	0.00

Appendix C BRKGA results for the Grundy coloring problem

Table 10: BRKGA-G and BRKGA+R+LS results for the random graphs.

	BRKGA-G			**BRKGA+R+LS**				
instance	mean	max	ttb	mean	max	ttb	$diff_{Mean}$	$diff_{Max}$
rand_50_0.2_01	11.00	11.00	30.2	11.00	11.00	10.4	0.00	0.00
rand_50_0.2_02	11.20	12.00	25.2	11.26	12.00	41.4	0.54	0.00
rand_50_0.2_03	11.02	12.00	12.0	11.10	12.00	22.6	0.73	0.00
rand_50_0.2_04	11.00	11.00	28.2	11.00	11.00	8.7	0.00	0.00
rand_50_0.2_05	11.66	12.00	83.5	11.98	12.00	65.9	2.76	0.00
rand_50_0.4_01	16.16	17.00	47.2	16.32	17.00	60.0	0.99	0.00
rand_50_0.4_02	16.34	17.00	51.7	16.92	17.00	67.1	3.55	0.00
rand_50_0.4_03	16.12	17.00	51.4	16.48	17.00	64.0	2.23	0.00
rand_50_0.4_04	16.52	17.00	74.6	16.92	17.00	84.4	2.42	0.00
rand_50_0.4_05	16.18	17.00	33.6	16.64	18.00	95.2	2.84	5.88
rand_50_0.6_01	23.00	24.00	75.0	23.32	24.00	63.7	1.39	0.00
rand_50_0.6_02	22.04	23.00	87.1	22.44	23.00	65.5	1.82	0.00
rand_50_0.6_03	22.61	23.00	90.6	23.04	24.00	90.7	1.90	4.35
rand_50_0.6_04	22.24	23.00	75.3	22.60	23.00	84.2	1.62	0.00
rand_50_0.6_05	23.20	24.00	77.4	23.58	24.00	84.1	1.64	0.00
rand_50_0.8_01	31.72	32.00	92.2	31.66	32.00	60.5	-0.19	0.00
rand_50_0.8_02	29.96	31.00	73.8	30.06	31.00	57.2	0.33	0.00
rand_50_0.8_03	29.90	31.00	60.4	29.98	31.00	51.9	0.27	0.00
rand_50_0.8_04	31.60	32.00	77.0	31.84	32.00	87.4	0.76	0.00
rand_50_0.8_05	30.77	31.00	85.9	30.84	31.00	84.1	0.23	0.00
rand_60_0.2_01	12.77	13.00	70.0	13.00	13.00	55.3	1.81	0.00
rand_60_0.2_02	12.28	13.00	31.0	12.86	13.00	79.7	4.72	0.00
rand_60_0.2_03	12.00	12.00	23.9	12.00	12.00	12.7	0.00	0.00
rand_60_0.2_04	12.06	13.00	22.0	12.10	13.00	19.9	0.33	0.00
rand_60_0.2_05	11.64	12.00	84.5	11.96	12.00	76.8	2.75	0.00
rand_60_0.4_01	19.20	20.00	48.7	19.66	20.00	122.4	2.40	0.00
rand_60_0.4_02	19.14	20.00	50.5	19.40	20.00	79.3	1.36	0.00
rand_60_0.4_03	18.12	19.00	64.9	18.52	20.00	84.5	2.23	5.26
rand_60_0.4_04	18.76	20.00	92.6	19.00	20.00	74.0	1.30	0.00
rand_60_0.4_05	18.98	20.00	69.1	19.32	20.00	66.4	1.79	0.00
rand_60_0.6_01	25.58	26.00	108.4	25.72	27.00	99.6	0.55	3.85
rand_60_0.6_02	25.82	27.00	87.0	26.16	27.00	78.4	1.32	0.00
rand_60_0.6_03	26.40	27.00	90.6	26.74	27.00	104.9	1.29	0.00
rand_60_0.6_04	25.54	26.00	93.2	25.98	27.00	80.9	1.72	3.85
rand_60_0.6_05	24.96	26.00	97.2	25.34	26.00	94.4	1.52	0.00
rand_60_0.8_01	35.38	36.00	73.2	35.60	37.00	93.2	0.61	2.78
rand_60_0.8_02	35.17	37.00	81.8	35.50	36.00	100.8	0.92	-2.70
rand_60_0.8_03	36.78	37.00	75.1	36.96	38.00	77.7	0.49	2.70
rand_60_0.8_04	36.26	37.00	76.0	36.54	37.00	94.5	0.77	0.00

rand_60_0.8_05	35.70	37.00	88.8	35.76	37.00	101.5	0.17	0.00
rand_70_0.2_01	13.18	14.00	33.7	13.44	14.00	60.8	1.97	0.00
rand_70_0.2_02	13.32	14.00	27.2	13.78	14.00	86.9	3.45	0.00
rand_70_0.2_03	13.00	14.00	6.7	13.22	14.00	30.0	1.69	0.00
rand_70_0.2_04	13.08	14.00	41.7	13.06	14.00	15.0	-0.13	0.00
rand_70_0.2_05	13.35	14.00	48.0	13.90	14.00	88.5	4.12	0.00
rand_70_0.4_01	20.08	21.00	54.8	20.46	21.00	71.2	1.89	0.00
rand_70_0.4_02	21.08	22.00	66.0	21.48	22.00	102.4	1.90	0.00
rand_70_0.4_03	20.80	22.00	92.6	21.18	22.00	83.2	1.83	0.00
rand_70_0.4_04	20.88	22.00	101.3	21.12	22.00	76.6	1.15	0.00
rand_70_0.4_05	21.12	22.00	80.7	21.28	22.00	56.1	0.76	0.00
rand_70_0.6_01	27.86	29.00	82.9	28.30	29.00	107.0	1.58	0.00
rand_70_0.6_02	28.04	29.00	99.9	28.28	29.00	101.3	0.86	0.00
rand_70_0.6_03	28.07	29.00	73.3	28.56	30.00	102.9	1.73	3.45
rand_70_0.6_04	28.24	29.00	84.8	28.68	30.00	109.6	1.56	3.45
rand_70_0.6_05	28.36	30.00	78.5	28.50	29.00	91.7	0.49	-3.33
rand_70_0.8_01	40.04	41.00	91.9	40.04	41.00	104.3	0.00	0.00
rand_70_0.8_02	39.82	41.00	69.4	40.12	41.00	117.9	0.75	0.00
rand_70_0.8_03	39.10	40.00	78.0	39.28	40.00	107.9	0.46	0.00
rand_70_0.8_04	39.68	41.00	93.8	39.94	41.00	114.2	0.66	0.00
rand_70_0.8_05	39.08	40.00	136.3	38.96	40.00	99.7	-0.30	0.00
rand_80_0.2_01	14.25	15.00	39.1	14.68	15.00	96.2	3.02	0.00
rand_80_0.2_02	14.44	15.00	43.4	14.86	15.00	95.1	2.91	0.00
rand_80_0.2_03	14.40	15.00	45.5	14.88	15.00	100.4	3.33	0.00
rand_80_0.2_04	13.70	15.00	58.8	14.02	15.00	43.8	2.34	0.00
rand_80_0.2_05	14.78	15.00	59.0	14.98	15.00	49.0	1.35	0.00
rand_80_0.4_01	22.68	24.00	57.7	23.06	24.00	78.0	1.68	0.00
rand_80_0.4_02	22.14	23.00	71.6	22.20	23.00	53.8	0.27	0.00
rand_80_0.4_03	22.08	23.00	64.8	22.36	23.00	67.9	1.28	0.00
rand_80_0.4_04	21.95	23.00	71.9	22.22	23.00	84.9	1.22	0.00
rand_80_0.4_05	22.50	24.00	67.9	22.90	23.00	113.1	1.78	-4.17
rand_80_0.6_01	31.06	32.00	74.5	31.34	32.00	94.3	0.90	0.00
rand_80_0.6_02	31.30	33.00	107.0	31.58	33.00	108.8	0.89	0.00
rand_80_0.6_03	30.74	32.00	71.9	30.96	32.00	111.8	0.72	0.00
rand_80_0.6_04	31.86	33.00	86.0	32.14	33.00	114.5	0.88	0.00
rand_80_0.6_05	31.86	33.00	131.6	31.98	33.00	113.8	0.38	0.00
rand_80_0.8_01	43.85	45.00	66.5	44.02	45.00	114.9	0.40	0.00
rand_80_0.8_02	43.27	44.00	72.1	43.58	45.00	111.8	0.72	2.27
rand_80_0.8_03	42.38	44.00	91.1	42.52	44.00	122.8	0.33	0.00
rand_80_0.8_04	42.94	45.00	84.1	43.26	44.00	136.2	0.75	-2.22
rand_80_0.8_05	43.28	45.00	96.7	43.60	45.00	133.4	0.74	0.00

Table 11: BRKGA-G and BRKGA+R+LS results for the geometric graphs.

	BRKGA-G			**BRKGA+R+LS**				
instance	mean	max	ttb	mean	max	ttb	$diff_{Mean}$	$diff_{Max}$
geo_50_0.2_01	9.00	9.00	0.1	9.00	9.00	0.1	0.00	0.00
geo_50_0.2_02	10.00	10.00	0.0	10.00	10.00	0.0	0.00	0.00
geo_50_0.2_03	8.00	8.00	0.0	8.00	8.00	0.0	0.00	0.00
geo_50_0.2_04	9.62	10.00	100.0	9.88	10.00	93.3	2.75	0.00
geo_50_0.2_05	8.00	8.00	0.0	8.00	8.00	0.0	0.00	0.00
geo_50_0.4_01	25.96	26.00	45.4	26.00	26.00	13.2	0.15	0.00
geo_50_0.4_02	19.00	19.00	0.0	19.00	19.00	0.0	0.00	0.00
geo_50_0.4_03	20.00	20.00	0.7	20.00	20.00	0.4	0.00	0.00
geo_50_0.4_04	22.64	23.00	75.4	22.58	23.00	65.6	-0.27	0.00
geo_50_0.4_05	23.00	23.00	8.3	23.00	23.00	8.3	0.00	0.00
geo_50_0.6_01	27.26	28.00	33.6	27.48	28.00	46.3	0.81	0.00
geo_50_0.6_02	32.81	33.00	58.4	32.88	33.00	45.6	0.22	0.00
geo_50_0.6_03	33.02	34.00	1.2	33.10	34.00	18.2	0.23	0.00
geo_50_0.6_04	30.84	31.00	52.9	30.94	31.00	33.5	0.32	0.00
geo_50_0.6_05	31.00	31.00	10.4	31.02	32.00	5.1	0.06	3.23
geo_50_0.8_01	40.00	40.00	2.9	40.00	40.00	1.9	0.00	0.00
geo_50_0.8_02	36.10	37.00	14.9	36.10	37.00	17.4	0.00	0.00
geo_50_0.8_03	40.00	40.00	0.0	40.00	40.00	0.3	0.00	0.00
geo_50_0.8_04	37.00	37.00	0.1	37.00	37.00	0.5	0.00	0.00
geo_50_0.8_05	36.00	36.00	1.6	36.00	36.00	3.6	0.00	0.00
geo_60_0.2_01	10.00	10.00	1.0	10.00	10.00	0.7	0.00	0.00
geo_60_0.2_02	9.00	9.00	1.3	9.00	9.00	0.2	0.00	0.00
geo_60_0.2_03	11.00	11.00	23.5	11.00	11.00	3.4	0.00	0.00
geo_60_0.2_04	9.00	9.00	0.1	9.00	9.00	0.1	0.00	0.00
geo_60_0.2_05	11.00	11.00	0.0	11.00	11.00	0.0	0.00	0.00
geo_60_0.4_01	26.32	27.00	64.1	26.40	27.00	71.3	0.30	0.00
geo_60_0.4_02	27.86	28.00	27.8	28.02	29.00	31.5	0.57	3.57
geo_60_0.4_03	25.00	25.00	13.9	25.00	25.00	6.4	0.00	0.00
geo_60_0.4_04	25.63	26.00	66.7	25.72	26.00	72.8	0.33	0.00
geo_60_0.4_05	26.44	27.00	36.1	26.58	27.00	23.9	0.53	0.00
geo_60_0.6_01	38.90	39.00	57.5	38.98	39.00	73.1	0.21	0.00
geo_60_0.6_02	39.04	40.00	11.6	39.18	40.00	35.2	0.36	0.00
geo_60_0.6_03	32.98	34.00	35.7	33.12	34.00	34.4	0.42	0.00
geo_60_0.6_04	38.86	39.00	38.7	38.98	39.00	42.6	0.31	0.00
geo_60_0.6_05	37.84	38.00	51.5	37.92	38.00	37.8	0.21	0.00
geo_60_0.8_01	49.00	49.00	0.1	49.00	49.00	1.3	0.00	0.00
geo_60_0.8_02	46.00	46.00	0.1	46.00	46.00	1.3	0.00	0.00
geo_60_0.8_03	45.84	46.00	47.5	45.82	46.00	40.4	-0.04	0.00
geo_60_0.8_04	48.52	49.00	48.4	48.80	49.00	63.8	0.58	0.00
geo_60_0.8_05	47.98	48.00	2.9	48.00	48.00	13.8	0.04	0.00
geo_70_0.2_01	11.20	12.00	25.8	11.52	12.00	69.2	2.86	0.00
geo_70_0.2_02	12.00	12.00	0.1	12.00	12.00	0.3	0.00	0.00

geo_70_0.2_03	12.00	12.00	0.3	12.00	12.00	0.1	0.00	0.00
geo_70_0.2_04	13.00	13.00	0.0	13.00	13.00	0.1	0.00	0.00
geo_70_0.2_05	13.00	13.00	0.3	13.00	13.00	0.8	0.00	0.00
geo_70_0.4_01	25.92	28.00	47.3	26.34	29.00	53.4	1.62	3.57
geo_70_0.4_02	29.40	30.00	75.2	29.70	30.00	95.3	1.02	0.00
geo_70_0.4_03	26.06	27.00	16.9	26.00	26.00	5.8	-0.23	-3.70
geo_70_0.4_04	29.10	30.00	46.5	29.40	30.00	78.7	1.03	0.00
geo_70_0.4_05	26.68	27.00	93.6	26.84	27.00	65.2	0.60	0.00
geo_70_0.6_01	37.12	38.00	70.8	37.08	38.00	48.5	-0.11	0.00
geo_70_0.6_02	44.00	44.00	13.6	44.02	45.00	13.3	0.05	2.27
geo_70_0.6_03	43.10	44.00	18.1	43.30	44.00	65.9	0.47	0.00
geo_70_0.6_04	41.10	42.00	46.7	41.20	42.00	56.1	0.24	0.00
geo_70_0.6_05	43.18	44.00	61.1	43.28	44.00	52.0	0.23	0.00
geo_70_0.8_01	58.84	59.00	32.5	58.90	59.00	29.8	0.10	0.00
geo_70_0.8_02	54.90	55.00	19.4	54.78	55.00	13.2	-0.22	0.00
geo_70_0.8_03	52.58	53.00	54.6	52.70	53.00	69.3	0.23	0.00
geo_70_0.8_04	51.90	52.00	44.2	52.00	52.00	52.7	0.19	0.00
geo_70_0.8_05	51.69	52.00	30.7	51.62	52.00	59.5	-0.14	0.00
geo_80_0.2_01	14.00	14.00	0.1	14.00	14.00	0.1	0.00	0.00
geo_80_0.2_02	11.00	11.00	0.1	11.00	11.00	0.1	0.00	0.00
geo_80_0.2_03	11.00	11.00	0.0	11.00	11.00	0.0	0.00	0.00
geo_80_0.2_04	14.00	14.00	0.2	14.00	14.00	0.1	0.00	0.00
geo_80_0.2_05	12.00	12.00	0.0	12.00	12.00	0.0	0.00	0.00
geo_80_0.4_01	32.04	33.00	27.5	32.06	33.00	26.5	0.06	0.00
geo_80_0.4_02	34.74	35.00	77.2	34.88	35.00	71.8	0.40	0.00
geo_80_0.4_03	28.54	29.00	121.0	28.36	29.00	97.9	-0.63	0.00
geo_80_0.4_04	31.41	32.00	24.7	31.54	33.00	38.2	0.41	3.12
geo_80_0.4_05	30.74	32.00	54.5	30.88	32.00	73.2	0.46	0.00
geo_80_0.6_01	46.00	47.00	64.5	46.04	47.00	70.3	0.09	0.00
geo_80_0.6_02	45.82	47.00	51.1	45.88	47.00	94.9	0.13	0.00
geo_80_0.6_03	51.14	52.00	27.9	51.14	52.00	35.9	0.00	0.00
geo_80_0.6_04	48.68	49.00	73.8	48.76	49.00	95.2	0.16	0.00
geo_80_0.6_05	46.94	47.00	43.1	46.90	48.00	55.7	-0.09	2.13
geo_80_0.8_01	64.00	64.00	0.4	64.00	64.00	16.9	0.00	0.00
geo_80_0.8_02	60.00	61.00	45.8	60.02	61.00	79.0	0.03	0.00
geo_80_0.8_03	63.00	63.00	0.3	63.00	63.00	4.6	0.00	0.00
geo_80_0.8_04	61.74	62.00	50.7	61.70	62.00	90.5	-0.06	0.00
geo_80_0.8_05	64.86	65.00	26.2	64.98	65.00	39.5	0.19	0.00

Table 12: BRKGA-G and BRKGA+R+LS results for the bipartite graphs.

	BRKGA-G			**BRKGA+R+LS**				
instance	mean	max	ttb	mean	max	ttb	$diff_{Mean}$	$diff_{Max}$
bip_50_0.2_01	7.08	8.00	11.2	7.44	8.00	72.3	5.08	0.00
bip_50_0.2_02	7.90	8.00	70.4	8.00	8.00	42.2	1.27	0.00

bip_50_0.2_03	8.00	8.00	10.3	8.00	8.00	4.7	0.00	0.00
bip_50_0.2_04	7.76	8.00	57.4	7.98	8.00	59.9	2.84	0.00
bip_50_0.2_05	7.06	8.00	6.7	7.28	8.00	41.7	3.12	0.00
bip_50_0.4_01	10.06	11.00	19.4	10.12	11.00	20.4	0.60	0.00
bip_50_0.4_02	10.06	11.00	21.5	10.16	11.00	23.7	0.99	0.00
bip_50_0.4_03	10.02	11.00	24.2	10.08	11.00	17.0	0.60	0.00
bip_50_0.4_04	10.02	11.00	12.4	10.18	11.00	27.1	1.60	0.00
bip_50_0.4_05	10.10	11.00	20.3	10.22	11.00	28.3	1.19	0.00
bip_50_0.6_01	11.96	13.00	84.5	12.04	13.00	31.7	0.67	0.00
bip_50_0.6_02	13.10	14.00	53.7	13.24	14.00	48.3	1.07	0.00
bip_50_0.6_03	12.90	13.00	64.2	13.14	14.00	48.7	1.86	7.69
bip_50_0.6_04	13.04	14.00	73.6	13.16	14.00	46.0	0.92	0.00
bip_50_0.6_05	12.80	13.00	49.3	13.00	13.00	55.6	1.56	0.00
bip_50_0.8_01	15.82	17.00	64.5	16.34	17.00	71.4	3.29	0.00
bip_50_0.8_02	13.70	15.00	54.4	14.42	15.00	81.6	5.26	0.00
bip_50_0.8_03	13.62	14.00	44.6	14.04	15.00	38.9	3.08	7.14
bip_50_0.8_04	15.46	17.00	57.6	15.98	17.00	115.2	3.36	0.00
bip_50_0.8_05	16.06	17.00	76.0	16.42	17.00	92.8	2.24	0.00
bip_60_0.2_01	8.32	9.00	34.4	8.76	9.00	68.4	5.29	0.00
bip_60_0.2_02	8.12	9.00	17.5	8.42	9.00	44.0	3.69	0.00
bip_60_0.2_03	8.00	8.00	1.9	8.12	9.00	19.4	1.50	12.50
bip_60_0.2_04	8.00	8.00	2.4	8.00	8.00	0.7	0.00	0.00
bip_60_0.2_05	8.32	9.00	40.9	8.76	9.00	102.9	5.29	0.00
bip_60_0.4_01	10.98	12.00	62.0	11.04	12.00	19.7	0.55	0.00
bip_60_0.4_02	10.62	11.00	67.2	11.02	12.00	38.7	3.77	9.09
bip_60_0.4_03	11.10	12.00	31.2	11.24	12.00	51.5	1.26	0.00
bip_60_0.4_04	11.04	12.00	43.5	11.08	12.00	19.3	0.36	0.00
bip_60_0.4_05	10.76	11.00	62.5	11.00	11.00	58.0	2.23	0.00
bip_60_0.6_01	13.80	15.00	86.1	14.04	15.00	71.6	1.74	0.00
bip_60_0.6_02	13.68	15.00	76.6	13.96	15.00	86.4	2.05	0.00
bip_60_0.6_03	13.96	15.00	85.5	14.08	15.00	44.1	0.86	0.00
bip_60_0.6_04	14.04	15.00	77.8	14.38	15.00	83.0	2.42	0.00
bip_60_0.6_05	13.80	15.00	86.4	14.12	15.00	88.5	2.32	0.00
bip_60_0.8_01	17.78	19.00	104.1	18.16	19.00	94.0	2.14	0.00
bip_60_0.8_02	16.18	18.00	73.1	16.86	18.00	108.5	4.20	0.00
bip_60_0.8_03	17.08	19.00	93.5	17.64	19.00	103.9	3.28	0.00
bip_60_0.8_04	17.12	18.00	95.8	17.48	19.00	95.6	2.10	5.56
bip_60_0.8_05	17.68	20.00	97.2	18.12	19.00	109.4	2.49	-5.00
bip_70_0.2_01	8.24	9.00	22.0	8.48	9.00	66.7	2.91	0.00
bip_70_0.2_02	9.26	10.00	27.7	9.66	10.00	85.0	4.32	0.00
bip_70_0.2_03	8.98	9.00	8.8	9.00	9.00	2.7	0.22	0.00
bip_70_0.2_04	8.06	9.00	9.8	8.22	9.00	34.4	1.99	0.00
bip_70_0.2_05	8.70	9.00	70.0	9.00	9.00	40.2	3.45	0.00
bip_70_0.4_01	12.14	13.00	69.6	12.30	13.00	51.8	1.32	0.00
bip_70_0.4_02	11.00	12.00	38.1	11.16	12.00	27.0	1.45	0.00

bip_70_0.4_03	11.64	12.00	67.1	12.02	13.00	67.7	3.26	8.33
bip_70_0.4_04	11.92	13.00	42.9	12.08	13.00	31.5	1.34	0.00
bip_70_0.4_05	11.64	12.00	94.5	11.92	12.00	82.8	2.41	0.00
bip_70_0.6_01	14.74	16.00	89.7	15.08	16.00	84.6	2.31	0.00
bip_70_0.6_02	14.94	16.00	73.4	15.36	16.00	72.8	2.81	0.00
bip_70_0.6_03	14.24	15.00	73.5	14.52	16.00	80.3	1.97	6.67
bip_70_0.6_04	14.72	16.00	74.8	15.00	16.00	84.6	1.90	0.00
bip_70_0.6_05	14.52	16.00	98.0	15.00	16.00	92.6	3.31	0.00
bip_70_0.8_01	19.20	21.00	129.8	19.54	21.00	102.8	1.77	0.00
bip_70_0.8_02	18.78	21.00	105.9	19.30	21.00	125.2	2.77	0.00
bip_70_0.8_03	17.72	19.00	89.7	18.48	20.00	97.6	4.29	5.26
bip_70_0.8_04	17.24	19.00	105.5	18.06	19.00	120.5	4.76	0.00
bip_70_0.8_05	18.86	21.00	122.7	19.36	21.00	112.1	2.65	0.00
bip_80_0.2_01	9.14	10.00	18.4	9.60	10.00	73.8	5.03	0.00
bip_80_0.2_02	9.86	10.00	67.1	10.00	10.00	24.7	1.42	0.00
bip_80_0.2_03	8.84	9.00	63.3	9.00	9.00	35.6	1.81	0.00
bip_80_0.2_04	9.52	10.00	54.9	9.90	10.00	92.3	3.99	0.00
bip_80_0.2_05	9.42	10.00	41.9	9.70	10.00	83.7	2.97	0.00
bip_80_0.4_01	12.72	14.00	92.6	12.90	14.00	69.8	1.42	0.00
bip_80_0.4_02	12.74	14.00	78.0	13.08	14.00	88.5	2.67	0.00
bip_80_0.4_03	13.18	14.00	68.9	13.28	14.00	51.4	0.76	0.00
bip_80_0.4_04	12.72	13.00	67.3	12.98	14.00	75.1	2.04	7.69
bip_80_0.4_05	12.86	14.00	74.9	13.00	14.00	51.5	1.09	0.00
bip_80_0.6_01	15.88	17.00	120.1	16.14	17.00	86.2	1.64	0.00
bip_80_0.6_02	16.02	17.00	111.9	16.30	17.00	72.0	1.75	0.00
bip_80_0.6_03	15.88	17.00	100.9	16.44	17.00	103.8	3.53	0.00
bip_80_0.6_04	16.00	17.00	94.3	16.44	18.00	100.8	2.75	5.88
bip_80_0.6_05	16.20	17.00	115.8	16.40	17.00	94.8	1.23	0.00
bip_80_0.8_01	19.90	22.00	110.3	20.54	22.00	120.8	3.22	0.00
bip_80_0.8_02	18.86	21.00	110.3	19.78	22.00	134.3	4.88	4.76
bip_80_0.8_03	19.46	21.00	120.1	20.14	22.00	122.8	3.49	4.76
bip_80_0.8_04	19.36	21.00	132.0	19.80	21.00	119.3	2.27	0.00
bip_80_0.8_05	19.34	21.00	105.9	20.06	21.00	131.2	3.72	0.00

Table 13: BRKGA-G and BRKGA+R+LS results for the complement of bipartite graphs.

	BRKGA-G			**BRKGA+R+LS**				
instance	mean	max	ttb	mean	max	ttb	$diff_{Mean}$	$diff_{Max}$
cbip_50_0.2_01	34.92	35.00	6.9	35.00	35.00	5.1	0.23	0.00
cbip_50_0.2_02	34.00	34.00	0.0	34.00	34.00	0.5	0.00	0.00
cbip_50_0.2_03	33.96	34.00	22.6	34.00	34.00	14.0	0.12	0.00
cbip_50_0.2_04	33.74	34.00	30.5	34.00	34.00	30.2	0.77	0.00
cbip_50_0.2_05	35.96	36.00	23.0	36.00	36.00	19.4	0.11	0.00
cbip_50_0.4_01	30.74	31.00	13.4	30.92	31.00	22.9	0.59	0.00
cbip_50_0.4_02	30.94	31.00	3.5	31.00	31.00	7.3	0.19	0.00

cbip_50_0.4_03	31.76	32.00	1.5	31.96	32.00	12.2	0.63	0.00
cbip_50_0.4_04	30.90	31.00	5.3	31.00	31.00	4.4	0.32	0.00
cbip_50_0.4_05	30.88	31.00	0.1	31.00	31.00	4.8	0.39	0.00
cbip_50_0.6_01	29.82	30.00	16.5	30.00	30.00	11.5	0.60	0.00
cbip_50_0.6_02	29.00	29.00	0.0	29.00	29.00	0.4	0.00	0.00
cbip_50_0.6_03	28.98	29.00	2.9	29.00	29.00	1.1	0.07	0.00
cbip_50_0.6_04	29.00	29.00	0.0	29.00	29.00	0.2	0.00	0.00
cbip_50_0.6_05	29.00	29.00	0.1	29.00	29.00	0.2	0.00	0.00
cbip_50_0.8_01	28.00	28.00	0.1	28.00	28.00	0.2	0.00	0.00
cbip_50_0.8_02	35.00	35.00	0.0	35.00	35.00	0.1	0.00	0.00
cbip_50_0.8_03	34.00	34.00	0.0	34.00	34.00	0.1	0.00	0.00
cbip_50_0.8_04	28.00	28.00	7.0	28.00	28.00	4.1	0.00	0.00
cbip_50_0.8_05	27.00	27.00	0.0	27.00	27.00	0.1	0.00	0.00
cbip_60_0.2_01	40.96	41.00	10.1	40.98	41.00	9.5	0.05	0.00
cbip_60_0.2_02	40.70	41.00	7.5	40.94	41.00	50.8	0.59	0.00
cbip_60_0.2_03	43.00	43.00	0.4	43.00	43.00	2.0	0.00	0.00
cbip_60_0.2_04	40.98	41.00	10.3	40.96	41.00	6.0	-0.05	0.00
cbip_60_0.2_05	40.72	41.00	17.7	40.98	41.00	34.2	0.64	0.00
cbip_60_0.4_01	38.98	39.00	11.2	39.00	39.00	10.0	0.05	0.00
cbip_60_0.4_02	39.66	40.00	3.7	39.64	40.00	11.1	-0.05	0.00
cbip_60_0.4_03	35.94	36.00	18.3	36.00	36.00	4.5	0.17	0.00
cbip_60_0.4_04	36.28	37.00	22.8	36.60	37.00	69.1	0.88	0.00
cbip_60_0.4_05	38.36	39.00	0.9	38.48	39.00	11.5	0.31	0.00
cbip_60_0.6_01	34.10	35.00	5.3	34.34	35.00	45.2	0.70	0.00
cbip_60_0.6_02	39.00	39.00	0.0	39.00	39.00	0.3	0.00	0.00
cbip_60_0.6_03	34.44	35.00	9.2	34.70	35.00	42.1	0.75	0.00
cbip_60_0.6_04	34.80	35.00	11.5	34.94	35.00	21.5	0.40	0.00
cbip_60_0.6_05	34.34	35.00	5.5	34.62	35.00	54.0	0.82	0.00
cbip_60_0.8_01	32.70	33.00	57.9	32.94	33.00	62.6	0.73	0.00
cbip_60_0.8_02	40.00	40.00	0.0	40.00	40.00	0.2	0.00	0.00
cbip_60_0.8_03	32.94	33.00	14.3	33.00	33.00	6.7	0.18	0.00
cbip_60_0.8_04	34.00	34.00	5.8	34.00	34.00	5.7	0.00	0.00
cbip_60_0.8_05	33.00	33.00	18.2	33.00	33.00	8.7	0.00	0.00
cbip_70_0.2_01	47.84	48.00	13.5	47.92	48.00	21.2	0.17	0.00
cbip_70_0.2_02	45.18	46.00	5.2	45.36	46.00	34.4	0.40	0.00
cbip_70_0.2_03	45.20	46.00	3.4	45.30	46.00	29.7	0.22	0.00
cbip_70_0.2_04	50.00	50.00	6.9	50.00	50.00	7.9	0.00	0.00
cbip_70_0.2_05	45.64	46.00	19.0	45.88	46.00	38.2	0.53	0.00
cbip_70_0.4_01	41.60	42.00	4.2	41.76	42.00	25.4	0.38	0.00
cbip_70_0.4_02	46.98	47.00	23.1	46.98	47.00	22.8	0.00	0.00
cbip_70_0.4_03	47.00	47.00	7.5	47.00	47.00	11.2	0.00	0.00
cbip_70_0.4_04	44.60	45.00	6.3	44.48	45.00	19.5	-0.27	0.00
cbip_70_0.4_05	42.26	43.00	1.8	42.36	43.00	16.2	0.24	0.00
cbip_70_0.6_01	40.00	40.00	0.6	40.00	40.00	1.9	0.00	0.00
cbip_70_0.6_02	39.84	40.00	0.7	39.90	40.00	25.6	0.15	0.00

cbip_70_0.6_03	45.00	45.00	0.0	45.00	45.00	0.5	0.00	0.00
cbip_70_0.6_04	39.92	40.00	0.2	40.00	40.00	5.8	0.20	0.00
cbip_70_0.6_05	43.58	44.00	81.6	43.68	44.00	111.4	0.23	0.00
cbip_70_0.8_01	38.60	39.00	3.0	38.84	39.00	29.2	0.62	0.00
cbip_70_0.8_02	39.00	39.00	3.8	39.00	39.00	3.6	0.00	0.00
cbip_70_0.8_03	45.00	45.00	0.0	45.00	45.00	0.4	0.00	0.00
cbip_70_0.8_04	45.00	45.00	0.0	45.00	45.00	0.4	0.00	0.00
cbip_70_0.8_05	38.00	38.00	0.2	38.00	38.00	0.8	0.00	0.00
cbip_80_0.2_01	51.94	52.00	0.7	51.76	52.00	17.9	-0.35	0.00
cbip_80_0.2_02	52.12	53.00	4.5	52.12	53.00	14.1	0.00	0.00
cbip_80_0.2_03	46.84	47.00	6.0	46.90	47.00	35.6	0.13	0.00
cbip_80_0.2_04	52.80	53.00	5.1	52.82	53.00	29.1	0.04	0.00
cbip_80_0.2_05	51.94	53.00	1.0	52.06	53.00	26.3	0.23	0.00
cbip_80_0.4_01	47.74	48.00	5.3	47.68	48.00	25.8	-0.13	0.00
cbip_80_0.4_02	46.88	47.00	8.2	46.96	47.00	20.6	0.17	0.00
cbip_80_0.4_03	47.14	48.00	18.1	47.10	48.00	31.3	-0.08	0.00
cbip_80_0.4_04	46.94	47.00	4.5	46.98	47.00	20.6	0.09	0.00
cbip_80_0.4_05	46.90	47.00	3.4	46.90	47.00	14.4	0.00	0.00
cbip_80_0.6_01	45.60	46.00	1.8	45.74	46.00	13.8	0.31	0.00
cbip_80_0.6_02	45.32	46.00	1.1	45.44	46.00	23.4	0.26	0.00
cbip_80_0.6_03	50.00	50.00	0.0	50.00	50.00	0.6	0.00	0.00
cbip_80_0.6_04	44.96	45.00	0.4	45.00	45.00	11.2	0.09	0.00
cbip_80_0.6_05	45.00	45.00	2.2	45.00	45.00	17.3	0.00	0.00
cbip_80_0.8_01	43.00	43.00	0.5	43.00	43.00	2.0	0.00	0.00
cbip_80_0.8_02	43.00	43.00	0.2	43.00	43.00	1.6	0.00	0.00
cbip_80_0.8_03	49.00	49.00	0.0	49.00	49.00	0.7	0.00	0.00
cbip_80_0.8_04	44.00	44.00	1.3	44.00	44.00	2.6	0.00	0.00
cbip_80_0.8_05	44.74	45.00	96.7	44.68	45.00	78.8	-0.13	0.00

Appendix D Comparing BRKGA's and IP results for the smaller instances with up to 30 vertices

Table 14: Results comparing BRKGA-B and BRKGA+R+LS with the best formulations result for the random graphs with at most 30 vertices.

	IP	**BRKGA-G**			**BRKGA+R+LS**		
instance	best	max	ttb	dev(%)	max	ttb	dev(%)
rand_15_0.2_01	4.0	4.0	0.0	0.0	4.0	0.0	0.0
rand_15_0.2_02	4.0	4.0	0.0	0.0	4.0	0.0	0.0
rand_15_0.2_03	5.0	5.0	0.0	0.0	5.0	0.0	0.0
rand_15_0.2_04	4.0	4.0	0.0	0.0	4.0	0.0	0.0
rand_15_0.2_05	4.0	4.0	0.0	0.0	4.0	0.0	0.0
rand_15_0.4_01	7.0	7.0	0.0	0.0	7.0	0.0	0.0
rand_15_0.4_02	7.0	7.0	0.0	0.0	7.0	0.0	0.0
rand_15_0.4_03	5.0	5.0	0.0	0.0	5.0	0.0	0.0
rand_15_0.4_04	7.0	7.0	0.0	0.0	7.0	0.0	0.0
rand_15_0.4_05	7.0	7.0	0.0	0.0	7.0	0.0	0.0
rand_15_0.6_01	9.0	9.0	0.0	0.0	9.0	0.0	0.0
rand_15_0.6_02	9.0	9.0	0.0	0.0	9.0	0.0	0.0
rand_15_0.6_03	9.0	9.0	0.0	0.0	9.0	0.0	0.0
rand_15_0.6_04	8.0	7.0	0.0	-14.3	7.0	0.0	-14.3
rand_15_0.6_05	9.0	9.0	0.0	0.0	9.0	0.0	0.0
rand_15_0.8_01	11.0	10.0	0.0	-10.0	10.0	0.0	-10.0
rand_15_0.8_02	12.0	12.0	0.0	0.0	12.0	0.0	0.0
rand_15_0.8_03	11.0	11.0	0.0	0.0	11.0	0.0	0.0
rand_15_0.8_04	10.0	10.0	0.0	0.0	10.0	0.0	0.0
rand_15_0.8_05	10.0	10.0	0.0	0.0	10.0	0.0	0.0
rand_20_0.2_01	6.0	6.0	0.0	0.0	6.0	0.0	0.0
rand_20_0.2_02	4.0	4.0	0.0	0.0	4.0	0.0	0.0
rand_20_0.2_03	6.0	6.0	0.0	0.0	6.0	0.0	0.0
rand_20_0.2_04	5.0	5.0	0.0	0.0	5.0	0.0	0.0
rand_20_0.2_05	6.0	6.0	0.0	0.0	6.0	0.0	0.0
rand_20_0.4_01	9.0	9.0	0.0	0.0	9.0	0.0	0.0
rand_20_0.4_02	9.0	8.0	0.0	-12.5	8.0	0.0	-12.5
rand_20_0.4_03	8.0	8.0	0.0	0.0	8.0	0.0	0.0
rand_20_0.4_04	8.0	8.0	0.0	0.0	8.0	0.0	0.0
rand_20_0.4_05	9.0	9.0	0.1	0.0	9.0	0.1	0.0
rand_20_0.6_01	10.0	11.0	0.1	9.1	11.0	0.1	9.1
rand_20_0.6_02	11.0	11.0	0.1	0.0	11.0	0.1	0.0
rand_20_0.6_03	11.0	11.0	0.9	0.0	11.0	0.9	0.0
rand_20_0.6_04	11.0	10.0	0.0	-10.0	10.0	0.0	-10.0
rand_20_0.6_05	12.0	11.0	0.0	-9.1	11.0	0.0	-9.1
rand_20_0.8_01	13.0	13.0	0.0	0.0	13.0	0.0	0.0
rand_20_0.8_02	13.0	13.0	0.0	0.0	13.0	0.0	0.0

rand_20_0.8_03	13.0	12.0	0.0	-8.3	12.0	0.0	-8.3
rand_20_0.8_04	13.0	12.0	0.0	-8.3	12.0	0.0	-8.3
rand_20_0.8_05	14.0	14.0	0.0	0.0	14.0	0.0	0.0
rand_25_0.2_01	7.0	8.0	0.1	12.5	8.0	0.1	12.5
rand_25_0.2_02	7.0	8.0	1.0	12.5	8.0	1.0	12.5
rand_25_0.2_03	7.0	7.0	0.0	0.0	7.0	0.0	0.0
rand_25_0.2_04	7.0	7.0	0.0	0.0	7.0	0.0	0.0
rand_25_0.2_05	6.0	7.0	0.1	14.3	7.0	0.0	14.3
rand_25_0.4_01	8.0	9.0	0.1	11.1	9.0	0.2	11.1
rand_25_0.4_02	8.0	10.0	0.0	20.0	10.0	0.0	20.0
rand_25_0.4_03	9.0	11.0	6.2	18.2	11.0	0.8	18.2
rand_25_0.4_04	9.0	10.0	0.0	10.0	10.0	0.0	10.0
rand_25_0.4_05	10.0	11.0	0.0	9.1	11.0	0.0	9.1
rand_25_0.6_01	11.0	13.0	6.6	15.4	13.0	3.5	15.4
rand_25_0.6_02	14.0	14.0	5.5	0.0	14.0	2.5	0.0
rand_25_0.6_03	13.0	14.0	6.4	7.1	14.0	3.1	7.1
rand_25_0.6_04	13.0	14.0	16.6	7.1	14.0	14.8	7.1
rand_25_0.6_05	12.0	14.0	3.8	14.3	14.0	7.1	14.3
rand_25_0.8_01	16.0	16.0	0.1	0.0	16.0	0.2	0.0
rand_25_0.8_02	17.0	16.0	0.0	-6.2	16.0	0.0	-6.2
rand_25_0.8_03	17.0	17.0	0.5	0.0	17.0	0.6	0.0
rand_25_0.8_04	17.0	17.0	0.0	0.0	17.0	0.0	0.0
rand_25_0.8_05	16.0	16.0	0.1	0.0	16.0	0.2	0.0
rand_30_0.2_01	7.0	9.0	1.3	22.2	9.0	0.6	22.2
rand_30_0.2_02	6.0	7.0	0.2	14.3	7.0	0.2	14.3
rand_30_0.2_03	7.0	8.0	9.7	12.5	8.0	19.4	12.5
rand_30_0.2_04	7.0	8.0	3.0	12.5	8.0	6.0	12.5
rand_30_0.2_05	7.0	7.0	0.0	0.0	7.0	0.0	0.0
rand_30_0.4_01	10.0	11.0	8.5	9.1	11.0	7.2	9.1
rand_30_0.4_02	10.0	11.0	1.0	9.1	11.0	0.3	9.1
rand_30_0.4_03	10.0	11.0	1.5	9.1	11.0	0.3	9.1
rand_30_0.4_04	10.0	12.0	13.2	16.7	12.0	16.1	16.7
rand_30_0.4_05	10.0	12.0	9.4	16.7	12.0	13.4	16.7
rand_30_0.6_01	15.0	16.0	8.6	6.2	16.0	11.0	6.2
rand_30_0.6_02	15.0	16.0	0.1	6.2	16.0	0.2	6.2
rand_30_0.6_03	13.0	15.0	0.5	13.3	15.0	0.3	13.3
rand_30_0.6_04	14.0	15.0	0.5	6.7	15.0	0.5	6.7
rand_30_0.6_05	13.0	16.0	12.3	18.8	16.0	15.3	18.8
rand_30_0.8_01	18.0	19.0	0.2	5.3	19.0	0.0	5.3
rand_30_0.8_02	18.0	20.0	0.6	10.0	20.0	0.5	10.0
rand_30_0.8_03	20.0	20.0	2.2	0.0	20.0	2.4	0.0
rand_30_0.8_04	17.0	19.0	0.2	10.5	19.0	0.4	10.5
rand_30_0.8_05	19.0	19.0	8.2	0.0	19.0	5.0	0.0

Table 15: Results comparing BRKGA-B and BRKGA+R+LS with the best formulations result for the geometric graphs with at most 30 vertices.

	IP	**BRKGA-G**			**BRKGA+R+LS**		
instance	best	max	ttb	dev(%)	max	ttb	dev(%)
geo_15_0.2_01	6.0	6.0	0.0	0.0	6.0	0.0	0.0
geo_15_0.2_02	3.0	3.0	0.0	0.0	3.0	0.0	0.0
geo_15_0.2_03	3.0	3.0	0.0	0.0	3.0	0.0	0.0
geo_15_0.2_04	3.0	3.0	0.0	0.0	3.0	0.0	0.0
geo_15_0.2_05	3.0	3.0	0.0	0.0	3.0	0.0	0.0
geo_15_0.4_01	7.0	7.0	0.0	0.0	7.0	0.0	0.0
geo_15_0.4_02	7.0	7.0	0.0	0.0	7.0	0.0	0.0
geo_15_0.4_03	6.0	5.0	0.0	-20.0	5.0	0.0	-20.0
geo_15_0.4_04	7.0	7.0	0.0	0.0	7.0	0.0	0.0
geo_15_0.4_05	7.0	7.0	0.0	0.0	7.0	0.0	0.0
geo_15_0.6_01	11.0	11.0	0.0	0.0	11.0	0.0	0.0
geo_15_0.6_02	11.0	11.0	0.0	0.0	11.0	0.0	0.0
geo_15_0.6_03	10.0	9.0	0.0	-11.1	9.0	0.0	-11.1
geo_15_0.6_04	10.0	10.0	0.0	0.0	10.0	0.0	0.0
geo_15_0.6_05	9.0	9.0	0.0	0.0	9.0	0.0	0.0
geo_15_0.8_01	12.0	11.0	0.0	-9.1	11.0	0.0	-9.1
geo_15_0.8_02	13.0	13.0	0.0	0.0	13.0	0.0	0.0
geo_15_0.8_03	11.0	11.0	0.0	0.0	11.0	0.0	0.0
geo_15_0.8_04	13.0	12.0	0.0	-8.3	12.0	0.0	-8.3
geo_15_0.8_05	13.0	12.0	0.0	-8.3	12.0	0.0	-8.3
geo_20_0.2_01	3.0	3.0	0.0	0.0	3.0	0.0	0.0
geo_20_0.2_02	4.0	4.0	0.0	0.0	4.0	0.0	0.0
geo_20_0.2_03	5.0	4.0	0.0	-25.0	4.0	0.0	-25.0
geo_20_0.2_04	3.0	3.0	0.0	0.0	3.0	0.0	0.0
geo_20_0.2_05	4.0	3.0	0.0	-33.3	3.0	0.0	-33.3
geo_20_0.4_01	9.0	10.0	25.5	10.0	10.0	25.5	10.0
geo_20_0.4_02	9.0	9.0	1.6	0.0	9.0	1.6	0.0
geo_20_0.4_03	12.0	11.0	0.0	-9.1	11.0	0.0	-9.1
geo_20_0.4_04	8.0	8.0	0.0	0.0	8.0	0.0	0.0
geo_20_0.4_05	10.0	10.0	0.0	0.0	10.0	0.0	0.0
geo_20_0.6_01	12.0	12.0	23.7	0.0	12.0	23.7	0.0
geo_20_0.6_02	14.0	14.0	0.0	0.0	14.0	0.0	0.0
geo_20_0.6_03	12.0	12.0	0.0	0.0	12.0	0.0	0.0
geo_20_0.6_04	11.0	11.0	0.0	0.0	11.0	0.0	0.0
geo_20_0.6_05	12.0	12.0	0.0	0.0	12.0	0.0	0.0
geo_20_0.8_01	16.0	15.0	0.0	-6.7	15.0	0.0	-6.7
geo_20_0.8_02	16.0	15.0	0.0	-6.7	15.0	0.0	-6.7
geo_20_0.8_03	15.0	15.0	0.0	0.0	15.0	0.0	0.0
geo_20_0.8_04	17.0	17.0	0.0	0.0	17.0	0.0	0.0
geo_20_0.8_05	16.0	16.0	0.0	0.0	16.0	0.0	0.0
geo_25_0.2_01	4.0	4.0	0.0	0.0	4.0	0.0	0.0

geo_25_0.2_02	4.0	4.0	0.0	0.0	4.0	0.0	0.0
geo_25_0.2_03	4.0	4.0	0.0	0.0	4.0	0.0	0.0
geo_25_0.2_04	4.0	4.0	0.0	0.0	4.0	0.0	0.0
geo_25_0.2_05	7.0	7.0	0.0	0.0	7.0	0.0	0.0
geo_25_0.4_01	9.0	10.0	0.0	10.0	10.0	0.0	10.0
geo_25_0.4_02	9.0	9.0	0.0	0.0	9.0	0.0	0.0
geo_25_0.4_03	13.0	13.0	0.0	0.0	13.0	0.0	0.0
geo_25_0.4_04	10.0	10.0	0.0	0.0	10.0	0.0	0.0
geo_25_0.4_05	12.0	12.0	0.0	0.0	12.0	0.0	0.0
geo_25_0.6_01	17.0	17.0	0.0	0.0	17.0	0.0	0.0
geo_25_0.6_02	15.0	15.0	0.0	0.0	15.0	0.0	0.0
geo_25_0.6_03	16.0	16.0	0.0	0.0	16.0	0.0	0.0
geo_25_0.6_04	16.0	16.0	0.1	0.0	16.0	0.1	0.0
geo_25_0.6_05	15.0	15.0	0.0	0.0	15.0	0.0	0.0
geo_25_0.8_01	18.0	18.0	0.0	0.0	18.0	0.0	0.0
geo_25_0.8_02	20.0	20.0	0.0	0.0	20.0	0.0	0.0
geo_25_0.8_03	20.0	20.0	0.0	0.0	20.0	0.0	0.0
geo_25_0.8_04	20.0	20.0	0.0	0.0	20.0	0.0	0.0
geo_25_0.8_05	20.0	20.0	0.0	0.0	20.0	0.0	0.0
geo_30_0.2_01	6.0	6.0	0.0	0.0	6.0	0.0	0.0
geo_30_0.2_02	5.0	4.0	0.0	-25.0	4.0	0.0	-25.0
geo_30_0.2_03	5.0	5.0	0.0	0.0	5.0	0.0	0.0
geo_30_0.2_04	6.0	6.0	0.0	0.0	6.0	0.0	0.0
geo_30_0.2_05	6.0	6.0	0.0	0.0	6.0	0.0	0.0
geo_30_0.4_01	12.0	12.0	1.6	0.0	12.0	1.6	0.0
geo_30_0.4_02	11.0	12.0	0.0	8.3	12.0	0.0	8.3
geo_30_0.4_03	10.0	12.0	2.2	16.7	12.0	2.2	16.7
geo_30_0.4_04	15.0	15.0	3.8	0.0	15.0	3.8	0.0
geo_30_0.4_05	15.0	16.0	0.2	6.2	16.0	0.2	6.2
geo_30_0.6_01	22.0	23.0	1.6	4.3	23.0	1.6	4.3
geo_30_0.6_02	19.0	20.0	1.4	5.0	20.0	1.4	5.0
geo_30_0.6_03	20.0	21.0	10.6	4.8	21.0	10.6	4.8
geo_30_0.6_04	18.0	20.0	0.5	10.0	20.0	0.5	10.0
geo_30_0.6_05	16.0	17.0	0.0	5.9	17.0	0.0	5.9
geo_30_0.8_01	23.0	23.0	0.0	0.0	23.0	0.0	0.0
geo_30_0.8_02	25.0	25.0	0.0	0.0	25.0	0.0	0.0
geo_30_0.8_03	25.0	24.0	0.0	-4.2	24.0	0.0	-4.2
geo_30_0.8_04	23.0	23.0	0.0	0.0	23.0	0.0	0.0
geo_30_0.8_05	21.0	22.0	0.0	4.5	22.0	0.0	4.5

Table 16: Results comparing BRKGA-B and BRKGA+R+LS with the best formulations result for the complement of bipartite graphs with at most 30 vertices.

	IP	**BRKGA-G**			**BRKGA+R+LS**		
instance	best	max	ttb	dev(%)	max	ttb	dev(%)
cbip_15_0.2_01	11.0	11.0	0.0	0.0	11.0	0.0	0.0
cbip_15_0.2_02	10.0	10.0	0.0	0.0	10.0	0.0	0.0
cbip_15_0.2_03	11.0	11.0	0.0	0.0	11.0	0.0	0.0
cbip_15_0.2_04	11.0	11.0	0.0	0.0	11.0	0.0	0.0
cbip_15_0.2_05	11.0	10.0	0.0	-10.0	10.0	0.0	-10.0
cbip_15_0.4_01	10.0	10.0	0.0	0.0	10.0	0.0	0.0
cbip_15_0.4_02	10.0	9.0	0.0	-11.1	9.0	0.0	-11.1
cbip_15_0.4_03	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_15_0.4_04	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_15_0.4_05	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_15_0.6_01	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_15_0.6_02	10.0	10.0	0.0	0.0	10.0	0.0	0.0
cbip_15_0.6_03	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_15_0.6_04	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_15_0.6_05	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_15_0.8_01	10.0	10.0	0.0	0.0	10.0	0.0	0.0
cbip_15_0.8_02	8.0	8.0	0.0	0.0	8.0	0.0	0.0
cbip_15_0.8_03	8.0	8.0	0.0	0.0	8.0	0.0	0.0
cbip_15_0.8_04	8.0	8.0	0.0	0.0	8.0	0.0	0.0
cbip_15_0.8_05	9.0	9.0	0.0	0.0	9.0	0.0	0.0
cbip_20_0.2_01	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_20_0.2_02	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_20_0.2_03	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_20_0.2_04	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_20_0.2_05	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_20_0.4_01	12.0	12.0	0.0	0.0	12.0	0.0	0.0
cbip_20_0.4_02	12.0	12.0	0.0	0.0	12.0	0.0	0.0
cbip_20_0.4_03	12.0	12.0	0.0	0.0	12.0	0.0	0.0
cbip_20_0.4_04	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_20_0.4_05	12.0	12.0	0.0	0.0	12.0	0.0	0.0
cbip_20_0.6_01	10.0	10.0	0.0	0.0	10.0	0.0	0.0
cbip_20_0.6_02	11.0	11.0	0.0	0.0	11.0	0.0	0.0
cbip_20_0.6_03	12.0	12.0	0.0	0.0	12.0	0.0	0.0
cbip_20_0.6_04	12.0	12.0	0.0	0.0	12.0	0.0	0.0
cbip_20_0.6_05	11.0	11.0	0.0	0.0	11.0	0.0	0.0
cbip_20_0.8_01	10.0	10.0	0.0	0.0	10.0	0.0	0.0
cbip_20_0.8_02	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_20_0.8_03	13.0	13.0	0.0	0.0	13.0	0.0	0.0
cbip_20_0.8_04	11.0	11.0	0.0	0.0	11.0	0.0	0.0
cbip_20_0.8_05	11.0	11.0	0.0	0.0	11.0	0.0	0.0
cbip_25_0.2_01	18.0	18.0	0.0	0.0	18.0	0.0	0.0

cbip_25_0.2_02	16.0	16.0	0.0	0.0	16.0	0.0	0.0
cbip_25_0.2_03	17.0	17.0	0.0	0.0	17.0	0.0	0.0
cbip_25_0.2_04	17.0	17.0	0.0	0.0	17.0	0.0	0.0
cbip_25_0.2_05	18.0	18.0	0.0	0.0	18.0	0.0	0.0
cbip_25_0.4_01	16.0	15.0	0.0	-6.7	15.0	0.0	-6.7
cbip_25_0.4_02	14.0	15.0	0.0	6.7	15.0	0.0	6.7
cbip_25_0.4_03	14.0	15.0	0.0	6.7	15.0	0.0	6.7
cbip_25_0.4_04	17.0	17.0	0.0	0.0	17.0	0.0	0.0
cbip_25_0.4_05	14.0	15.0	0.0	6.7	15.0	0.0	6.7
cbip_25_0.6_01	13.0	13.0	0.0	0.0	13.0	0.0	0.0
cbip_25_0.6_02	18.0	18.0	0.0	0.0	18.0	0.0	0.0
cbip_25_0.6_03	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_25_0.6_04	15.0	15.0	0.0	0.0	15.0	0.0	0.0
cbip_25_0.6_05	15.0	15.0	0.0	0.0	15.0	0.0	0.0
cbip_25_0.8_01	13.0	13.0	0.0	0.0	13.0	0.0	0.0
cbip_25_0.8_02	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_25_0.8_03	13.0	13.0	0.0	0.0	13.0	0.0	0.0
cbip_25_0.8_04	14.0	14.0	0.0	0.0	14.0	0.0	0.0
cbip_25_0.8_05	16.0	16.0	0.0	0.0	16.0	0.0	0.0
cbip_30_0.2_01	23.0	23.0	0.0	0.0	23.0	0.0	0.0
cbip_30_0.2_02	19.0	20.0	0.0	5.0	20.0	0.0	5.0
cbip_30_0.2_03	19.0	20.0	1.1	5.0	20.0	1.1	5.0
cbip_30_0.2_04	19.0	20.0	0.0	5.0	20.0	0.0	5.0
cbip_30_0.2_05	23.0	23.0	0.1	0.0	23.0	0.1	0.0
cbip_30_0.4_01	17.0	17.0	0.0	0.0	17.0	0.0	0.0
cbip_30_0.4_02	20.0	20.0	0.0	0.0	20.0	0.0	0.0
cbip_30_0.4_03	22.0	22.0	0.0	0.0	22.0	0.0	0.0
cbip_30_0.4_04	24.0	24.0	0.0	0.0	24.0	0.0	0.0
cbip_30_0.4_05	17.0	17.0	0.0	0.0	17.0	0.0	0.0
cbip_30_0.6_01	19.0	19.0	0.0	0.0	19.0	0.0	0.0
cbip_30_0.6_02	16.0	16.0	0.0	0.0	16.0	0.0	0.0
cbip_30_0.6_03	16.0	16.0	0.0	0.0	16.0	0.0	0.0
cbip_30_0.6_04	16.0	16.0	0.0	0.0	16.0	0.0	0.0
cbip_30_0.6_05	16.0	16.0	0.0	0.0	16.0	0.0	0.0
cbip_30_0.8_01	16.0	16.0	0.0	0.0	16.0	0.0	0.0
cbip_30_0.8_02	15.0	15.0	0.0	0.0	15.0	0.0	0.0
cbip_30_0.8_03	15.0	15.0	0.0	0.0	15.0	0.0	0.0
cbip_30_0.8_04	17.0	17.0	0.0	0.0	17.0	0.0	0.0
cbip_30_0.8_05	18.0	18.0	0.0	0.0	18.0	0.0	0.0