Results for Scheduling Benchmark Classes

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Abstract

this reposts lists results of the *tbischeduling* tool for a number of existing benchmarks on scheduling related problems. THe results indicate that depending on the problem type, only a fraction of the benchmarks are solved to optimality, while good or reasonable results are obtained by CPOptimizer of IBM.

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Chapter 1

Introduction

The results are obtained by running the TestAll main routine for the different benchmark problems, selecting the necessary parameters and limits for each benchmark type.

The detailed execution time depends on many parameters that are not well controlled in the test environment, so the results should be considered with caution. Tests were run on a Windows 11 laptop using CPOptimizer 22.1.0.

Chapter 2

Taillard Open Shop Problems

All problems are solved to optimality, possible due to their small to moderate size.

Table 2.1: Results for Taillard OpenShop (60 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai10 10 0.json	10	10	Optimal	0.45	637	637.00	0.00
tai10 10 1.json	10	10	Optimal	0.06	588	588.00	0.00
tai10 10 2.json	10	10	Optimal	0.27	598	598.00	0.00
tai10 10 3.json	10	10	Optimal	0.05	577	577.00	0.00
tai10 10 4.json	10	10	Optimal	0.05	640	640.00	0.00
tai10 10 5.json	10	10	Optimal	0.04	538	538.00	0.00
tai10 10 6.json	10	10	Optimal	0.06	616	616.00	0.00
tai10 10 7.json	10	10	Optimal	0.11	595	595.00	0.00
tai10 10 8.json	10	10	Optimal	0.05	595	595.00	0.00
tai10 10 9.json	10	10	Optimal	0.08	596	596.00	0.00
tai15 15 0.json	15	15	Optimal	0.11	937	937.00	0.00
tai15 15 1.json	15	15	Optimal	0.11	918	918.00	0.00
tai15 15 2.json	15	15	Optimal	0.08	871	871.00	0.00
tai15 15 3.json	15	15	Optimal	0.13	934	934.00	0.00
tai15 15 4.json	15	15	Optimal	0.09	946	946.00	0.00
tai15 15 5.json	15	15	Optimal	0.08	933	933.00	0.00
tai15 15 6.json	15	15	Optimal	0.16	891	891.00	0.00
tai15 15 7.json	15	15	Optimal	0.13	893	893.00	0.00
tai15 15 8.json	15	15	Optimal	0.28	899	899.00	0.00
tai15 15 9.json	15	15	Optimal	0.17	902	902.00	0.00
tai20 20 0.json	20	20	Optimal	0.35	1155	1155.00	0.00
tai20 20 1.json	20	20	Optimal	1.00	1241	1241.00	0.00
tai20 20 2.json	20	20	Optimal	0.56	1257	1257.00	0.00
tai20 20 3.json	20	20	Optimal	0.25	1248	1248.00	0.00
tai20 20 4.json	20	20	Optimal	0.19	1256	1256.00	0.00

Table 2.1: Results for Taillard OpenShop (60 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai20 20 5.json	20	20	Optimal	0.16	1204	1204.00	0.00
tai20 20 6.json	20	20	Optimal	0.66	1294	1294.00	0.00
tai20 20 7.json	20	20	Optimal	1.18	1169	1169.00	0.00
tai20 20 8.json	20	20	Optimal	0.17	1289	1289.00	0.00
tai20 20 9.json	20	20	Optimal	0.17	1241	1241.00	0.00
tai4 4 0.json	4	4	Optimal	0.13	193	193.00	0.00
tai4 4 1.json	4	4	Optimal	0.11	236	236.00	0.00
tai4 4 2.json	4	4	Optimal	0.08	271	271.00	0.00
tai4 4 3.json	4	4	Optimal	0.15	250	250.00	0.00
tai4 4 4.json	4	4	Optimal	0.17	295	295.00	0.00
tai4 4 5.json	4	4	Optimal	0.05	189	189.00	0.00
tai4 4 6.json	4	4	Optimal	0.10	201	201.00	0.00
tai4 4 7.json	4	4	Optimal	0.05	217	217.00	0.00
tai4 4 8.json	4	4	Optimal	0.13	261	261.00	0.00
tai4 4 9.json	4	4	Optimal	0.12	217	217.00	0.00
tai5 5 0.json	5	5	Optimal	0.18	300	300.00	0.00
tai5 5 1.json	5	5	Optimal	0.16	262	262.00	0.00
tai5 5 2.json	5	5	Optimal	0.20	323	323.00	0.00
tai5 5 3.json	5	5	Optimal	0.17	310	310.00	0.00
tai5 5 4.json	5	5	Optimal	0.27	326	326.00	0.00
tai5 5 5.json	5	5	Optimal	0.16	312	312.00	0.00
tai5 5 6.json	5	5	Optimal	0.21	303	303.00	0.00
tai5 5 7.json	5	5	Optimal	0.25	300	300.00	0.00
tai5 5 8.json	5	5	Optimal	0.17	353	353.00	0.00
tai5 5 9.json	5	5	Optimal	0.25	326	326.00	0.00
tai7 7 0.json	7	7	Optimal	0.03	435	435.00	0.00
tai7 7 1.json	7	7	Optimal	0.12	443	443.00	0.00
tai7 7 2.json	7	7	Optimal	0.31	468	468.00	0.00
tai7 7 3.json	7	7	Optimal	0.03	463	463.00	0.00
tai7 7 4.json	7	7	Optimal	0.03	416	416.00	0.00
tai7 7 5.json	7	7	Optimal	0.80	451	451.00	0.00
tai7 7 6.json	7	7	Optimal	1.10	422	422.00	0.00
tai7 7 7.json	7	7	Optimal	0.05	424	424.00	0.00
tai7 7 8.json	7	7	Optimal	0.09	458	458.00	0.00
tai7 7 9.json	7	7	Optimal	0.06	398	398.00	0.00

Chapter 3

Taillard Job Shop Problems

The results are rather confusing, as some smaller problems cannot be solved to optimality, while complete groups of larger instances can. The number of jobs clearly is not the only indicator of difficulty of these problems.

Table 3.1: Results for Taillard JobShop (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 20 0.json	100	20	Optimal	444.79	5464	5464.00	0.00
tai100 20 1.json	100	20	Optimal	129.42	5181	5181.00	0.00
tai100 20 2.json	100	20	Optimal	127.22	5568	5568.00	0.00
tai100 20 3.json	100	20	Optimal	63.90	5339	5339.00	0.00
tai100 20 4.json	100	20	Optimal	224.02	5392	5392.00	0.00
tai100 20 5.json	100	20	Optimal	199.92	5342	5342.00	0.00
tai100 20 6.json	100	20	Optimal	76.52	5436	5436.00	0.00
tai100 20 7.json	100	20	Optimal	251.01	5394	5394.00	0.00
tai100 20 8.json	100	20	Optimal	108.09	5358	5358.00	0.00
tai100 20 9.json	100	20	Optimal	458.28	5183	5183.00	0.00
tai15 15 0.json	15	15	Optimal	8.67	1231	1231.00	0.00
tai15 15 1.json	15	15	Optimal	38.99	1244	1244.00	0.00
tai15 15 2.json	15	15	Optimal	22.16	1218	1218.00	0.00
tai15 15 3.json	15	15	Optimal	26.67	1175	1175.00	0.00
tai15 15 4.json	15	15	Optimal	180.42	1224	1224.00	0.00
tai15 15 5.json	15	15	Solution	600.02	1238	1168.00	5.65
tai15 15 6.json	15	15	Optimal	97.97	1227	1227.00	0.00
tai15 15 7.json	15	15	Optimal	117.59	1217	1217.00	0.00
tai15 15 8.json	15	15	Optimal	133.02	1274	1274.00	0.00
tai15 15 9.json	15	15	Optimal	39.26	1241	1241.00	0.00
tai20 15 0.json	20	15	Solution	600.02	1393	1310.00	5.96
tai20 15 1.json	20	15	Solution	600.02	1373	1316.00	4.15
tai20 15 2.json	20	15	Solution	600.02	1360	1243.00	8.60
tai20 15 3.json	20	15	Optimal	113.40	1345	1345.00	0.00
tai20 15 4.json	20	15	Solution	600.02	1373	1268.00	7.65
tai20 15 5.json	20	15	Solution	600.02	1378	1302.00	5.52

Table 3.1: Results for Taillard JobShop (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai20 15 6.json	20	15	Optimal	52.56	1462	1462.00	0.00
tai20 15 7.json	20	15	Solution	600.04	1425	1358.00	4.70
tai20 15 8.json	20	15	Solution	600.02	1366	1257.00	7.98
tai20 15 9.json	20	15	Solution	600.02	1360	1300.00	4.41
tai20 20 0.json	20	20	Solution	600.03	1687	1508.00	10.61
tai20 20 1.json	20	20	Solution	600.02	1651	1468.00	11.08
tai20 20 2.json	20	20	Solution	600.02	1561	1461.00	6.41
tai20 20 3.json	20	20	Solution	600.03	1650	1595.00	3.33
tai20 20 4.json	20	20	Solution	600.02	1619	1520.00	6.11
tai20 20 5.json	20	20	Solution	600.02	1676	1502.00	10.38
tai20 20 6.json	20	20	Solution	600.03	1694	1619.00	4.43
tai20 20 7.json	20	20	Solution	600.02	1614	1561.00	3.28
tai20 20 8.json	20	20	Solution	600.02	1642	1518.00	7.55
tai20 20 9.json	20	20	Solution	600.03	1640	1424.00	13.17
tai30 15 0.json	30	15	Solution	600.03	1766	1764.00	0.11
tai30 15 1.json	30	15	Solution	600.02	1845	1774.00	3.85
tai30 15 2.json	30	15	Solution	600.03	1842	1774.00	3.69
tai30 15 3.json	30	15	Solution	600.03	1846	1828.00	0.98
tai30 15 4.json	30	15	Optimal	17.38	2007	2007.00	0.00
tai30 15 5.json	30	15	Solution	600.03	1825	1819.00	0.33
tai30 15 6.json	30	15	Solution	600.02	1791	1771.00	1.12
tai30 15 7.json	30	15	Solution	600.03	1690	1673.00	1.01
tai30 15 8.json	30	15	Solution	600.03	1821	1795.00	1.43
tai30 15 9.json	30	15	Solution	600.03	1740	1631.00	6.26
tai30 20 0.json	30	20	Solution	600.04	2061	1857.00	9.90
tai30 20 1.json	30	20	Solution	600.04	2001	1867.00	6.70
tai30 20 2.json	30	20	Solution	600.04	1889	1809.00	4.24
tai30 20 3.json	30	20	Solution	600.03	2027	1923.00	5.13
tai30 20 4.json	30	20	Solution	600.04	2037	1996.00	2.01
tai30 20 5.json	30	20	Solution	600.03	2095	1940.00	7.40
tai30 20 6.json	30	20	Solution	600.04	1959	1781.00	9.09
tai30 20 7.json	30	20	Solution	600.04	1991	1905.00	4.32
tai30 20 8.json	30	20	Solution	600.03	2027	1903.00	6.12
tai30 20 9.json	30	20	Solution	600.01	2009	1806.00	10.10
tai50 15 0.json	50	15	Optimal	51.18	2760	2760.00	0.00
tai50 15 1.json	50	15	Optimal	25.88	2756	2756.00	0.00
tai50 15 2.json	50	15	Optimal	22.48	2717	2717.00	0.00
tai50 15 3.json	50	15	Optimal	12.41	2839	2839.00	0.00
tai50 15 4.json	50	15	Optimal	56.78	2679	2679.00	0.00
tai50 15 5.json	50	15	Optimal	17.82	2781	2781.00	0.00
tai50 15 6.json	50	15	Optimal	20.21	2943	2943.00	0.00
tai50 15 7.json	50	15	Optimal	10.34	2885	2885.00	0.00
tai50 15 8.json	50	15	Optimal	65.13	2655	2655.00	0.00
tai50 15 9.json	50	15	Optimal	15.40	2723	2723.00	0.00
tai50 20 0.json	50	20	Optimal	82.49	2868	2868.00	0.00

Table 3.1: Results for Taillard JobShop (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai50 20 1.json	50	20	Solution	600.10	2901	2869.00	1.10
tai50 20 2.json	50	20	Optimal	436.81	2755	2755.00	0.00
tai50 20 3.json	50	20	Optimal	250.89	2702	2702.00	0.00
tai50 20 4.json	50	20	Optimal	500.55	2725	2725.00	0.00
tai50 20 5.json	50	20	Solution	600.10	2881	2845.00	1.25
tai50 20 6.json	50	20	Solution	600.11	2826	2825.00	0.04
tai50 20 7.json	50	20	Optimal	164.25	2784	2784.00	0.00
tai50 20 8.json	50	20	Optimal	79.35	3071	3071.00	0.00
tai50 20 9.json	50	20	Optimal	386.69	2995	2995.00	0.00

3.1 Sample Results on Mac

For a selected subset of the tests, we also tried running on a mac laptop, results show some good improvement of the m2 based laptop over the Intel based Windows machine, but the improvements are not consistent.

Table 3.2: Results for Taillard Jobshop (Selected Instances on Mac)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 20 0.json	100	20	Optimal	143.93	5464	5464.00	0.00
tai100 20 1.json	100	20	Optimal	86.52	5181	5181.00	0.00
tai100 20 2.json	100	20	Optimal	63.63	5568	5568.00	0.00
tai100 20 3.json	100	20	Optimal	19.51	5339	5339.00	0.00
tai100 20 4.json	100	20	Optimal	174.11	5392	5392.00	0.00
tai100 20 5.json	100	20	Optimal	80.95	5342	5342.00	0.00
tai100 20 6.json	100	20	Optimal	139.30	5436	5436.00	0.00
tai100 20 7.json	100	20	Optimal	48.86	5394	5394.00	0.00
tai100 20 8.json	100	20	Optimal	82.22	5358	5358.00	0.00
tai100 20 9.json	100	20	Optimal	143.55	5183	5183.00	0.00

Chapter 4

Taillard Flow Shop Problems

These problems seem to be more difficult to solve to optimality. The number of stages seems to make a huge difference, we can solve the problems with five stages (machines) much more easily than the problems with 10 or twenty stages.

Table 4.1: Results for Taillard Flowshop (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 10 0.json	100	10	Solution	600.16	5979	5759.00	3.68
tai100 10 1.json	100	10	Solution	600.06	5418	5345.00	1.35
tai100 10 2.json	100	10	Solution	600.06	5798	5646.00	2.62
tai100 10 3.json	100	10	Solution	600.03	6040	5737.00	5.02
tai100 10 4.json	100	10	Solution	600.02	5663	5431.00	4.10
tai100 10 5.json	100	10	Solution	600.05	5378	5274.00	1.93
tai100 10 6.json	100	10	Solution	600.04	5697	5553.00	2.53
tai100 10 7.json	100	10	Solution	600.03	5813	5575.00	4.09
tai100 10 8.json	100	10	Solution	600.04	5983	5838.00	2.42
tai100 10 9.json	100	10	Solution	600.02	5903	5835.00	1.15
tai100 20 0.json	100	20	Solution	600.07	6731	5914.00	12.14
tai100 20 1.json	100	20	Solution	600.05	6840	6115.00	10.60
tai100 20 2.json	100	20	Solution	600.06	6778	6139.00	9.43
tai100 20 3.json	100	20	Solution	600.06	6720	6117.00	8.97
tai100 20 4.json	100	20	Solution	600.05	6853	6148.00	10.29
tai100 20 5.json	100	20	Solution	600.07	6989	6192.00	11.40
tai100 20 6.json	100	20	Solution	600.04	6772	6045.00	10.74
tai100 20 7.json	100	20	Solution	600.05	6940	6113.00	11.92
tai100 20 8.json	100	20	Solution	600.04	7092	6014.00	15.20
tai100 20 9.json	100	20	Solution	600.06	6871	6359.00	7.45
tai100 5 0.json	100	5	Optimal	73.90	5493	5493.00	0.00
tai100 5 1.json	100	5	Solution	600.13	5276	5232.00	0.83
tai100 5 2.json	100	5	Solution	600.11	5178	5170.00	0.15
tai100 5 3.json	100	5	Solution	600.12	4996	4993.00	0.06

Table 4.1: Results for Taillard Flowshop (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 5 4.json	100	5	Optimal	79.87	5247	5247.00	0.00
tai100 5 5.json	100	5	Optimal	231.03	5135	5135.00	0.00
tai100 5 6.json	100	5	Optimal	95.07	5232	5232.00	0.00
tai100 5 7.json	100	5	Optimal	293.37	5083	5083.00	0.00
tai100 5 8.json	100	5	Solution	600.12	5464	5438.00	0.48
tai100 5 9.json	100	5	Optimal	70.58	5318	5318.00	0.00
tai200 10 0.json	200	10	Solution	600.06	11136	10842.00	2.64
tai200 10 1.json	200	10	Solution	600.04	10981	10429.00	5.03
tai200 10 2.json	200	10	Solution	600.06	11276	10915.00	3.20
tai200 10 3.json	200	10	Solution	600.06	11217	10826.00	3.49
tai200 10 4.json	200	10	Solution	600.06	11139	10474.00	5.97
tai200 10 5.json	200	10	Solution	600.06	10828	10311.00	4.77
tai200 10 6.json	200	10	Solution	600.07	11202	10825.00	3.37
tai200 10 7.json	200	10	Solution	600.07	11287	10709.00	5.12
tai200 10 8.json	200	10	Solution	600.07	11004	10419.00	5.32
tai200 10 9.json	200	10	Solution	600.05	11178	10664.00	4.60
tai200 20 0.json	200	20	Solution	600.11	12439	11010.00	11.49
tai200 20 1.json	200	20	Solution	600.12	12878	10976.00	14.77
tai200 20 2.json	200	20	Solution	600.12	12506	11168.00	10.70
tai200 20 3.json	200	20	Solution	600.09	12618	11131.00	11.78
tai200 20 4.json	200	20	Solution	600.06	12649	11160.00	11.77
tai200 20 5.json	200	20	Solution	600.13	12740	11114.00	12.76
tai200 20 6.json	200	20	Solution	600.10	12985	11249.00	13.37
tai200 20 7.json	200	20	Solution	600.08	12724	11149.00	12.38
tai200 20 8.json	200	20	Solution	600.07	12693	11013.00	13.24
tai200 20 9.json	200	20	Solution	600.07	12869	11167.00	13.23
tai20 10 0.json	20	10	Solution	600.01	1575	1494.00	5.14
tai20 10 1.json	20	10	Solution	600.02	1648	1555.00	5.64
tai20 10 2.json	20	10	Solution	600.04	1477	1430.00	3.18
tai20 10 3.json	20	10	Optimal	170.76	1356	1356.00	0.00
tai20 10 4.json	20	10	Solution	600.04	1403	1353.00	3.56
tai20 10 5.json	20	10	Solution	600.03	1374	1352.00	1.60
tai20 10 6.json	20	10	Solution	600.03	1446	1388.00	4.01
tai20 10 7.json	20	10	Solution	600.02	1579	1407.00	10.89
tai20 10 8.json	20	10	Optimal	74.54	1586	1586.00	0.00
tai20 10 9.json	20	10	Solution	600.02	1600	1473.00	7.94
tai20 20 0.json	20	20	Solution	600.04	2284	1970.00	13.75
tai20 20 1.json	20	20	Solution	600.05	2109	1784.00	15.41
tai20 20 2.json	20	20	Solution	600.05	2341	1924.00	17.81
tai20 20 3.json	20	20	Solution	600.04	2266	1892.00	16.50
tai20 20 4.json	20	20	Solution	600.04	2311	1994.00	13.72
tai20 20 5.json	20	20	Solution	600.03	2215	1899.00	14.27
tai20 20 6.json	20	20	Solution	600.03	2265	1952.00	13.82
tai20 20 7.json	20	20	Solution	600.04	2206	1931.00	12.47
tai20 20 8.json	20	20	Solution	600.03	2233	1900.00	14.91

Table 4.1: Results for Taillard Flowshop (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai20 20 9.json	20	20	Solution	600.03	2181	1939.00	11.10
tai20 5 0.json	20	5	Optimal	3.03	1278	1278.00	0.00
tai20 5 1.json	20	5	Optimal	2.20	1358	1358.00	0.00
tai20 5 2.json	20	5	Optimal	2.72	1073	1073.00	0.00
tai20 5 3.json	20	5	Optimal	3.28	1292	1292.00	0.00
tai20 5 4.json	20	5	Optimal	5.46	1231	1231.00	0.00
tai20 5 5.json	20	5	Optimal	2.45	1193	1193.00	0.00
tai20 5 6.json	20	5	Optimal	1.89	1234	1234.00	0.00
tai20 5 7.json	20	5	Optimal	3.99	1199	1199.00	0.00
tai20 5 8.json	20	5	Optimal	1.72	1210	1210.00	0.00
tai20 5 9.json	20	5	Optimal	1.76	1103	1103.00	0.00
tai500 20 0.json	500	20	Solution	600.23	28669	25931.00	9.55
tai500 20 1.json	500	20	Solution	600.18	29047	26390.00	9.15
tai500 20 2.json	500	20	Solution	600.22	28796	26330.00	8.56
tai500 20 3.json	500	20	Solution	600.18	28907	26456.00	8.48
tai500 20 4.json	500	20	Solution	600.21	28841	26205.00	9.14
tai500 20 5.json	500	20	Solution	600.19	28954	26436.00	8.70
tai500 20 6.json	500	20	Solution	600.17	28750	26329.00	8.42
tai500 20 7.json	500	20	Solution	600.17	28924	26451.00	8.55
tai500 20 8.json	500	20	Solution	600.19	28038	25929.00	7.52
tai500 20 9.json	500	20	Solution	600.22	28726	26355.00	8.25
tai50 10 0.json	50	10	Solution	600.07	3055	2962.00	3.04
tai50 10 1.json	50	10	Solution	600.10	2929	2829.00	3.41
tai50 10 2.json	50	10	Solution	600.11	2908	2825.00	2.85
tai50 10 3.json	50	10	Solution	600.06	3125	3038.00	2.78
tai50 10 4.json	50	10	Solution	600.06	3100	2923.00	5.71
tai50 10 5.json	50	10	Solution	600.11	3065	2966.00	3.23
tai50 10 6.json	50	10	Solution	600.06	3133	3063.00	2.23
tai50 10 7.json	50	10	Solution	600.11	3096	3000.00	3.10
tai50 10 8.json	50	10	Solution	600.09	2959	2832.00	4.29
tai50 10 9.json	50	10	Solution	600.08	3111	3046.00	2.09
tai50 20 0.json	50	20	Solution	600.17	4003	3562.00	11.02
tai50 20 1.json	50	20	Solution	600.20	4041	3533.00	12.57
tai50 20 2.json	50	20	Solution	600.18	3972	3412.00	14.10
tai50 20 3.json	50	20	Solution	600.16	3922	3383.00	13.74
tai50 20 4.json	50	20	Solution	600.15	3830	3387.00	11.57
tai50 20 5.json	50	20	Solution	600.19	3861	3499.00	9.38
tai50 20 6.json	50	20	Solution	600.21	3930	3461.00	11.93
tai50 20 7.json	50	20	Solution	60.25	4056	3411.00	15.90
tai50 20 8.json	50	20	Solution	60.17	4115	3468.00	15.72
tai50 20 9.json	50	20	Solution	60.19	3986	3474.00	12.84
tai50 5 0.json	50	5	Optimal	17.70	2724	2724.00	0.00
tai50 5 1.json	50	5	Optimal	57.29	2834	2834.00	0.00
tai50 5 2.json	50	5	Optimal	47.53	2612	2612.00	0.00
tai50 5 3.json	50	5	Optimal	11.58	2751	2751.00	0.00

Table 4.1: Results for Taillard Flowshop (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai50 5 4.json	50	5	Optimal	23.50	2853	2853.00	0.00
tai50 5 5.json	50	5	Optimal	28.67	2825	2825.00	0.00
tai50 5 6.json	50	5	Optimal	42.14	2716	2716.00	0.00
tai50 5 7.json	50	5	Optimal	19.26	2683	2683.00	0.00
tai50 5 8.json	50	5	Optimal	56.32	2545	2545.00	0.00
tai50 5 9.json	50	5	Optimal	5.82	2776	2776.00	0.00

4.1 Permutation Flowshop Results for Taillard

We can run the flowshop benchmarks with an additional constraint to be solved as a permutation flowshop, which dramatically reduces the sets of feasible solutions, and the search tree to be searched. This might results in improved solutions found as a larger part of that search space can be explored, but solutions can be worse than for the original problem. In particular the optimal solution for the permutation flowshop can be worse than a good feasible solution for the unrestricted flowshop.

Table 4.2: Results for Taillard Flowshop (120 Instances) As Permutation Flowshop

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 10 0.json	100	10	Solution	600.34	5789	5766.00	0.40
tai100 10 1.json	100	10	Solution	600.07	5391	5347.00	0.82
tai100 10 2.json	100	10	Solution	600.08	5691	5659.00	0.56
tai100 10 3.json	100	10	Solution	600.06	5860	5776.00	1.43
tai100 10 4.json	100	10	Solution	600.05	5513	5450.00	1.14
tai100 10 5.json	100	10	Solution	600.03	5308	5290.00	0.34
tai100 10 6.json	100	10	Solution	600.03	5647	5556.00	1.61
tai100 10 7.json	100	10	Solution	600.03	5689	5586.00	1.81
tai100 10 8.json	100	10	Solution	600.05	5903	5865.00	0.64
tai100 10 9.json	100	10	Solution	600.04	5860	5837.00	0.39
tai100 20 0.json	100	20	Solution	600.05	6526	5936.00	9.04
tai100 20 1.json	100	20	Solution	600.07	6390	6122.00	4.19
tai100 20 2.json	100	20	Solution	600.07	6481	6162.00	4.92
tai100 20 3.json	100	20	Solution	600.08	6463	6163.00	4.64
tai100 20 4.json	100	20	Solution	600.05	6497	6161.00	5.17
tai100 20 5.json	100	20	Solution	600.05	6554	6203.00	5.36
tai100 20 6.json	100	20	Solution	600.07	6483	6061.00	6.51
tai100 20 7.json	100	20	Solution	600.08	6670	6190.00	7.20
tai100 20 8.json	100	20	Solution	600.05	6577	6063.00	7.82
tai100 20 9.json	100	20	Solution	600.06	6684	6382.00	4.52
tai100 5 0.json	100	5	Optimal	4.06	5493	5493.00	0.00

Table 4.2: Results for Taillard Flowshop (120 Instances) As Permutation Flowshop

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 5 1.json	100	5	Optimal	67.53	5268	5268.00	0.00
tai100 5 2.json	100	5	Optimal	7.66	5175	5175.00	0.00
tai100 5 3.json	100	5	Optimal	60.38	5014	5014.00	0.00
tai100 5 4.json	100	5	Optimal	62.17	5250	5250.00	0.00
tai100 5 5.json	100	5	Optimal	6.22	5135	5135.00	0.00
tai100 5 6.json	100	5	Optimal	9.45	5246	5246.00	0.00
tai100 5 7.json	100	5	Optimal	9.90	5094	5094.00	0.00
tai100 5 8.json	100	5	Optimal	65.13	5448	5448.00	0.00
tai100 5 9.json	100	5	Optimal	67.74	5322	5322.00	0.00
tai200 10 0.json	200	10	Solution	600.05	10918	10861.00	0.52
tai200 10 1.json	200	10	Solution	600.07	10718	10447.00	2.53
tai200 10 2.json	200	10	Solution	600.05	11060	10920.00	1.27
tai200 10 3.json	200	10	Solution	600.07	10934	10846.00	0.80
tai200 10 4.json	200	10	Solution	600.08	10626	10494.00	1.24
tai200 10 5.json	200	10	Solution	600.07	10453	10312.00	1.35
tai200 10 6.json	200	10	Solution	600.07	10979	10853.00	1.15
tai200 10 7.json	200	10	Solution	600.07	10856	10715.00	1.30
tai200 10 8.json	200	10	Solution	600.06	10558	10422.00	1.29
tai200 10 9.json	200	10	Solution	600.05	10761	10666.00	0.88
tai200 20 0.json	200	20	Solution	600.13	11928	11048.00	7.38
tai200 20 1.json	200	20	Solution	600.09	11991	11009.00	8.19
tai200 20 2.json	200	20	Solution	600.09	12248	11217.00	8.42
tai200 20 3.json	200	20	Solution	600.12	11967	11179.00	6.58
tai200 20 4.json	200	20	Solution	600.13	11915	11168.00	6.27
tai200 20 5.json	200	20	Solution	600.08	11923	11159.00	6.41
tai200 20 6.json	200	20	Solution	600.10	12205	11269.00	7.67
tai200 20 7.json	200	20	Solution	600.10	12221	11216.00	8.22
tai200 20 8.json	200	20	Solution	600.12	11991	11054.00	7.81
tai200 20 9.json	200	20	Solution	600.11	12022	11242.00	6.49
tai20 10 0.json	20	10	Optimal	292.19	1582	1582.00	0.00
tai20 10 1.json	20	10	Solution	600.02	1659	1580.00	4.76
tai20 10 2.json	20	10	Optimal	587.59	1496	1496.00	0.00
tai20 10 3.json	20	10	Optimal	62.06	1377	1377.00	0.00
tai20 10 4.json	20	10	Optimal	101.03	1419	1419.00	0.00
tai20 10 5.json	20	10	Optimal	119.12	1397	1397.00	0.00
tai20 10 6.json	20	10	Solution	600.02	1484	1399.00	5.73
tai20 10 7.json	20	10	Optimal	357.94	1538	1538.00	0.00
tai20 10 8.json	20	10	Optimal	31.26	1593	1593.00	0.00
tai20 10 9.json	20	10	Solution	600.04	1603	1492.00	6.92
tai20 20 0.json	20	20	Solution	600.04	2340	2010.00	14.10
tai20 20 1.json	20	20	Solution	600.03	2130	1823.00	14.41
tai20 20 2.json	20	20	Solution	600.04	2329	1945.00	16.49
tai20 20 3.json	20	20	Solution	600.04	2229	1933.00	13.28
tai20 20 4.json	20	20	Solution	600.02	2324	2034.00	12.48

Table 4.2: Results for Taillard Flowshop (120 Instances) As Permutation Flowshop

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai20 20 5.json	20	20	Solution	600.04	2235	1967.00	11.99
tai20 20 6.json	20	20	Solution	600.05	2291	1976.00	13.75
tai20 20 7.json	20	20	Solution	600.04	2222	1936.00	12.87
tai20 20 8.json	20	20	Solution	600.04	2250	1909.00	15.16
tai20 20 9.json	20	20	Solution	600.02	2189	1954.00	10.74
tai20 5 0.json	20	5	Optimal	0.79	1278	1278.00	0.00
tai20 5 1.json	20	5	Optimal	0.39	1359	1359.00	0.00
tai20 5 2.json	20	5	Optimal	0.76	1081	1081.00	0.00
tai20 5 3.json	20	5	Optimal	1.38	1293	1293.00	0.00
tai20 5 4.json	20	5	Optimal	4.98	1235	1235.00	0.00
tai20 5 5.json	20	5	Optimal	0.45	1195	1195.00	0.00
tai20 5 6.json	20	5	Optimal	0.37	1234	1234.00	0.00
tai20 5 7.json	20	5	Optimal	1.22	1206	1206.00	0.00
tai20 5 8.json	20	5	Optimal	0.65	1230	1230.00	0.00
tai20 5 9.json	20	5	Optimal	0.58	1108	1108.00	0.00
tai500 20 0.json	500	20	Solution	600.40	28935	25955.00	10.30
tai500 20 1.json	500	20	Solution	600.21	29270	26432.00	9.70
tai500 20 2.json	500	20	Solution	600.25	28956	26330.00	9.07
tai500 20 3.json	500	20	Solution	600.21	28977	26456.00	8.70
tai500 20 4.json	500	20	Solution	600.23	28999	26263.00	9.43
tai500 20 5.json	500	20	Solution	600.28	28939	26440.00	8.64
tai500 20 6.json	500	20	Solution	600.27	28709	26362.00	8.18
tai500 20 7.json	500	20	Solution	600.29	29115	26514.00	8.93
tai500 20 8.json	500	20	Solution	600.22	28659	25952.00	9.45
tai500 20 9.json	500	20	Solution	600.25	28948	26429.00	8.70
tai50 10 0.json	50	10	Solution	600.09	3039	2967.00	2.37
tai50 10 1.json	50	10	Solution	600.09	2933	2829.00	3.55
tai50 10 2.json	50	10	Solution	600.11	2921	2828.00	3.18
tai50 10 3.json	50	10	Optimal	535.73	3063	3063.00	0.00
tai50 10 4.json	50	10	Solution	600.10	3021	2928.00	3.08
tai50 10 5.json	50	10	Solution	600.12	3050	2987.00	2.07
tai50 10 6.json	50	10	Solution	600.10	3124	3065.00	1.89
tai50 10 7.json	50	10	Solution	600.05	3040	3037.00	0.10
tai50 10 8.json	50	10	Solution	600.12	2902	2883.00	0.65
tai50 10 9.json	50	10	Solution	600.06	3121	3046.00	2.40
tai50 20 0.json	50	20	Solution	600.21	3931	3591.00	8.65
tai50 20 1.json	50	20	Solution	600.24	3812	3534.00	7.29
tai50 20 2.json	50	20	Solution	600.24	3756	3428.00	8.73
tai50 20 3.json	50	20	Solution	600.24	3817	3453.00	9.54
tai50 20 4.json	50	20	Solution	600.20	3736	3389.00	9.29
tai50 20 5.json	50	20	Solution	600.17	3784	3535.00	6.58
tai50 20 6.json	50	20	Solution	600.18	3799	3495.00	8.00
tai50 20 7.json	50	20	Solution	600.18	3836	3443.00	10.25
tai50 20 8.json	50	20	Solution	600.22	3908	3482.00	10.90

Table 4.2: Results for Taillard Flowshop (120 Instances) As Permutation Flowshop

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai50 20 9.json	50	20	Solution	600.16	3857	3538.00	8.27
tai50 5 0.json	50	5	Optimal	1.24	2724	2724.00	0.00
tai50 5 1.json	50	5	Optimal	2.71	2834	2834.00	0.00
tai50 5 2.json	50	5	Optimal	32.80	2621	2621.00	0.00
tai50 5 3.json	50	5	Optimal	1.66	2751	2751.00	0.00
tai50 5 4.json	50	5	Optimal	2.22	2863	2863.00	0.00
tai50 5 5.json	50	5	Optimal	3.09	2829	2829.00	0.00
tai50 5 6.json	50	5	Optimal	14.28	2725	2725.00	0.00
tai50 5 7.json	50	5	Optimal	2.61	2683	2683.00	0.00
tai50 5 8.json	50	5	Optimal	3.82	2552	2552.00	0.00
tai50 5 9.json	50	5	Optimal	2.03	2782	2782.00	0.00

Chapter 5

SALBP-1 Assembly Line Balancing Problems

The assembly line balancing problems have a single cumulative and no disjunctive constraints, so the indicated number of (disjunctive) machines is zero.

The larger problem instances are still missing. For the small instances (20 tasks), only a few are not solved to optimality, for the medium sizes the number of optimal solutions found is reduced, and for larger instances, optimal solutions are rare.

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 1.alb	1	0	Optimal	0.14	3	3.00	0.00
instance n=20 10.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 100.alb	1	0	Optimal	0.22	11	11.00	0.00
instance n=20 101.alb	1	0	Optimal	1.99	13	13.00	0.00
instance n=20 102.alb	1	0	Optimal	0.33	13	13.00	0.00
instance n=20 103.alb	1	0	Optimal	0.10	12	12.00	0.00
instance n=20 104.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 105.alb	1	0	Optimal	0.10	12	12.00	0.00
instance n=20 106.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 107.alb	1	0	Optimal	0.96	14	14.00	0.00
instance n=20 108.alb	1	0	Optimal	1.37	15	15.00	0.00
instance n=20 109.alb	1	0	Optimal	0.24	12	12.00	0.00
instance n=20 11.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 110.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 111.alb	1	0	Optimal	0.26	13	13.00	0.00
instance n=20 112.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 113.alb	1	0	Optimal	0.25	12	12.00	0.00
instance n=20 114.alb	1	0	Optimal	0.34	13	13.00	0.00
instance n=20 115.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 116.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 117.alb	1	0	Optimal	0.03	5	5.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 118.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 119.alb	1	0	Optimal	0.06	6	6.00	0.00
instance n=20 12.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 120.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 121.alb	1	0	Optimal	0.05	5	5.00	0.00
instance n=20 122.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 123.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 124.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 125.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 126.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 127.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 128.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 129.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 13.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 130.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 131.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=20 132.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 133.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 134.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 135.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 136.alb	1	0	Optimal	0.11	6	6.00	0.00
instance n=20 137.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 138.alb	1	0	Optimal	0.05	5	5.00	0.00
instance n=20 139.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 14.alb	1	0	Optimal	0.05	3	3.00	0.00
instance n=20 140.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 141.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 142.alb	1	0	Optimal	0.04	3	3.00	0.00
instance n=20 143.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 144.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 145.alb	1	0	Optimal	0.04	3	3.00	0.00
instance n=20 146.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 147.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 148.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 149.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 15.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 150.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 151.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 152.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 153.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 154.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 155.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 156.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 157.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 158.alb	1	0	Optimal	0.02	3	3.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 159.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 16.alb	1	0	Optimal	0.33	12	12.00	0.00
instance n=20 160.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 161.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 162.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 163.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 164.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 165.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 166.alb	1	0	Optimal	1.90	12	12.00	0.00
instance n=20 167.alb	1	0	Optimal	0.70	11	11.00	0.00
instance n=20 168.alb	1	0	Optimal	0.09	10	10.00	0.00
instance n=20 169.alb	1	0	Optimal	0.27	11	11.00	0.00
instance n=20 17.alb	1	0	Optimal	0.05	10	10.00	0.00
instance n=20 170.alb	1	0	Optimal	0.08	11	11.00	0.00
instance n=20 171.alb	1	0	Optimal	21.85	13	13.00	0.00
instance n=20 172.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 173.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=20 174.alb	1	0	Optimal	0.38	12	12.00	0.00
instance n=20 175.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 176.alb	1	0	Optimal	0.44	11	11.00	0.00
instance n=20 177.alb	1	0	Optimal	0.71	10	10.00	0.00
instance n=20 178.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 179.alb	1	0	Optimal	0.06	11	11.00	0.00
instance n=20 18.alb	1	0	Optimal	0.33	11	11.00	0.00
instance n=20 180.alb	1	0	Optimal	5.92	13	13.00	0.00
instance n=20 181.alb	1	0	Optimal	0.10	11	11.00	0.00
instance n=20 182.alb	1	0	Optimal	0.96	11	11.00	0.00
instance n=20 183.alb	1	0	Optimal	4.86	13	13.00	0.00
instance n=20 184.alb	1	0	Optimal	0.80	12	12.00	0.00
instance n=20 185.alb	1	0	Optimal	7.53	15	15.00	0.00
instance n=20 186.alb	1	0	Optimal	5.00	14	14.00	0.00
instance n=20 187.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 188.alb	1	0	Optimal	0.17	11	11.00	0.00
instance n=20 189.alb	1	0	Optimal	1.08	13	13.00	0.00
instance n=20 19.alb	1	0	Optimal	3.41	14	14.00	0.00
instance n=20 190.alb	1	0	Optimal	22.71	15	15.00	0.00
instance n=20 191.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 192.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 193.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 194.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 195.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 196.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 197.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 198.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 199.alb	1	0	Optimal	0.03	5	5.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 2.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 20.alb	1	0	Optimal	0.25	11	11.00	0.00
instance n=20 200.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 201.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 202.alb	1	0	Optimal	0.11	4	4.00	0.00
instance n=20 203.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 204.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 205.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 206.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 207.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 208.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 209.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 21.alb	1	0	Optimal	1.57	14	14.00	0.00
instance n=20 210.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 211.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 212.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 213.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 214.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 215.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 216.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 217.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 218.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 219.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 22.alb	1	0	Optimal	0.52	12	12.00	0.00
instance n=20 220.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 221.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 222.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 223.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 224.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 225.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 226.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 227.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 228.alb	1	0	Optimal	0.02	2	2.00	0.00
instance n=20 229.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 23.alb	1	0	Optimal	11.89	13	13.00	0.00
instance n=20 230.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 231.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 232.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 233.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 234.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 235.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 236.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 237.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 238.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 239.alb	1	0	Optimal	0.02	3	3.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 24.alb	1	0	Optimal	0.10	11	11.00	0.00
instance n=20 240.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 241.alb	1	0	Optimal	0.19	13	13.00	0.00
instance n=20 242.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 243.alb	1	0	Optimal	0.10	10	10.00	0.00
instance n=20 244.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 245.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=20 246.alb	1	0	Optimal	0.27	13	13.00	0.00
instance n=20 247.alb	1	0	Optimal	0.12	11	11.00	0.00
instance n=20 248.alb	1	0	Optimal	0.10	11	11.00	0.00
instance n=20 249.alb	1	0	Optimal	0.29	13	13.00	0.00
instance n=20 25.alb	1	0	Optimal	0.19	11	11.00	0.00
instance n=20 250.alb	1	0	Optimal	0.05	10	10.00	0.00
instance n=20 251.alb	1	0	Optimal	0.10	12	12.00	0.00
instance n=20 252.alb	1	0	Optimal	0.18	11	11.00	0.00
instance n=20 253.alb	1	0	Optimal	0.25	13	13.00	0.00
instance n=20 254.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 255.alb	1	0	Optimal	0.41	13	13.00	0.00
instance n=20 256.alb	1	0	Optimal	0.16	14	14.00	0.00
instance n=20 257.alb	1	0	Optimal	0.02	10	10.00	0.00
instance n=20 258.alb	1	0	Optimal	0.17	13	13.00	0.00
instance n=20 259.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=20 26.alb	1	0	Optimal	0.94	12	12.00	0.00
instance n=20 260.alb	1	0	Optimal	0.36	12	12.00	0.00
instance n=20 261.alb	1	0	Optimal	0.08	12	12.00	0.00
instance n=20 262.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 263.alb	1	0	Optimal	0.17	12	12.00	0.00
instance n=20 264.alb	1	0	Optimal	0.17	12	12.00	0.00
instance n=20 265.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 266.alb	1	0	Optimal	0.11	5	5.00	0.00
instance n=20 267.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 268.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 269.alb	1	0	Optimal	0.10	7	7.00	0.00
instance n=20 27.alb	1	0	Optimal	2.72	13	13.00	0.00
instance n=20 270.alb	1	0	Optimal	0.09	7	7.00	0.00
instance n=20 271.alb	1	0	Optimal	0.11	6	6.00	0.00
instance n=20 272.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 273.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 274.alb	1	0	Optimal	0.11	6	6.00	0.00
instance n=20 275.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 276.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 277.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 278.alb	1	0	Optimal	0.11	6	6.00	0.00
instance n=20 279.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 28.alb	1	0	Optimal	1.92	12	12.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 280.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 281.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 282.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 283.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 284.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 285.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 286.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 287.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 288.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 289.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 29.alb	1	0	Optimal	0.02	10	10.00	0.00
instance n=20 290.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 291.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 292.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 293.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 294.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 295.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 296.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 297.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 298.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 299.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 3.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 30.alb	1	0	Optimal	12.29	16	16.00	0.00
instance n=20 300.alb	1	0	Optimal	0.04	4	4.00	0.00
instance n=20 301.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 302.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 303.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 304.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 305.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 306.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 307.alb	1	0	Optimal	0.04	3	3.00	0.00
instance n=20 308.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 309.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 31.alb	1	0	Optimal	0.49	12	12.00	0.00
instance n=20 310.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 311.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 312.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 313.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 314.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 315.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 316.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 317.alb	1	0	Optimal	0.30	10	10.00	0.00
instance n=20 318.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 319.alb	1	0	Optimal	3.37	14	14.00	0.00
instance n=20 32.alb	1	0	Optimal	13.44	13	13.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 320.alb	1	0	Optimal	0.46	12	12.00	0.00
instance n=20 321.alb	1	0	Solution	30.02	14	12.00	14.29
instance n=20 322.alb	1	0	Optimal	3.34	12	12.00	0.00
instance n=20 323.alb	1	0	Optimal	2.38	13	13.00	0.00
instance n=20 324.alb	1	0	Optimal	0.09	9	9.00	0.00
instance n=20 325.alb	1	0	Optimal	20.95	14	14.00	0.00
instance n=20 326.alb	1	0	Optimal	6.60	14	14.00	0.00
instance n=20 327.alb	1	0	Optimal	6.61	13	13.00	0.00
instance n=20 328.alb	1	0	Optimal	4.54	13	13.00	0.00
instance n=20 329.alb	1	0	Optimal	0.04	10	10.00	0.00
instance n=20 33.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 330.alb	1	0	Optimal	3.45	12	12.00	0.00
instance n=20 331.alb	1	0	Optimal	6.17	13	13.00	0.00
instance n=20 332.alb	1	0	Optimal	1.07	13	13.00	0.00
instance n=20 333.alb	1	0	Optimal	0.25	11	11.00	0.00
instance n=20 334.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 335.alb	1	0	Solution	30.01	14	11.00	21.43
instance n=20 336.alb	1	0	Optimal	0.17	11	11.00	0.00
instance n=20 337.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 338.alb	1	0	Optimal	3.81	14	14.00	0.00
instance n=20 339.alb	1	0	Optimal	5.20	13	13.00	0.00
instance n=20 34.alb	1	0	Optimal	1.13	12	12.00	0.00
instance n=20 340.alb	1	0	Optimal	0.39	11	11.00	0.00
instance n=20 341.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 342.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 343.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 344.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 345.alb	1	0	Optimal	0.04	4	4.00	0.00
instance n=20 346.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 347.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 348.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 349.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 35.alb	1	0	Optimal	0.41	12	12.00	0.00
instance n=20 350.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 351.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 352.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 353.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 354.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 355.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 356.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 357.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 358.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 359.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 36.alb	1	0	Optimal	0.85	13	13.00	0.00
instance n=20 360.alb	1	0	Optimal	0.03	6	6.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 361.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 362.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 363.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=20 364.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 365.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 366.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 367.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 368.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 369.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 37.alb	1	0	Optimal	0.58	12	12.00	0.00
instance n=20 370.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 371.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 372.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 373.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 374.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 375.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 376.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 377.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 378.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 379.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 38.alb	1	0	Optimal	0.19	12	12.00	0.00
instance n=20 380.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 381.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 382.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 383.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 384.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 385.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 386.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 387.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 388.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 389.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 39.alb	1	0	Optimal	0.32	13	13.00	0.00
instance n=20 390.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 391.alb	1	0	Optimal	0.11	11	10.00	9.09
instance n=20 392.alb	1	0	Optimal	0.24	14	14.00	0.00
instance n=20 393.alb	1	0	Optimal	0.19	11	10.00	9.09
instance n=20 394.alb	1	0	Optimal	0.19	12	12.00	0.00
instance n=20 395.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 396.alb	1	0	Optimal	0.33	13	13.00	0.00
instance n=20 397.alb	1	0	Optimal	0.10	10	10.00	0.00
instance n=20 398.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 399.alb	1	0	Optimal	0.25	13	13.00	0.00
instance n=20 4.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 40.alb	1	0	Optimal	1.21	12	12.00	0.00
instance n=20 400.alb	1	0	Optimal	0.17	12	12.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 401.alb	1	0	Optimal	0.19	12	12.00	0.00
instance n=20 402.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 403.alb	1	0	Optimal	0.17	12	12.00	0.00
instance n=20 404.alb	1	0	Optimal	0.20	10	10.00	0.00
instance n=20 405.alb	1	0	Optimal	0.17	12	12.00	0.00
instance n=20 406.alb	1	0	Optimal	0.61	14	14.00	0.00
instance n=20 407.alb	1	0	Optimal	0.05	10	10.00	0.00
instance n=20 408.alb	1	0	Optimal	0.42	14	14.00	0.00
instance n=20 409.alb	1	0	Optimal	0.16	12	12.00	0.00
instance n=20 41.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 410.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 411.alb	1	0	Optimal	0.87	15	15.00	0.00
instance n=20 412.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 413.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 414.alb	1	0	Optimal	0.37	12	12.00	0.00
instance n=20 415.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 416.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 417.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 418.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 419.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 42.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 420.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 421.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 422.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 423.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 424.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 425.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 426.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 427.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 428.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 429.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 43.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 430.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 431.alb	1	0	Optimal	0.04	6	6.00	0.00
instance n=20 432.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 433.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 434.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 435.alb	1	0	Optimal	0.12	7	7.00	0.00
instance n=20 436.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 437.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 438.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 439.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 44.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 440.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 441.alb	1	0	Optimal	0.01	3	3.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 442.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 443.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 444.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 445.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 446.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 447.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 448.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 449.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 45.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 450.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 451.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 452.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 453.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 454.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 455.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 456.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 457.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 458.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 459.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 46.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 460.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 461.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 462.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 463.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 464.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 465.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 466.alb	1	0	Optimal	0.11	13	13.00	0.00
instance n=20 467.alb	1	0	Optimal	0.11	14	14.00	0.00
instance n=20 468.alb	1	0	Optimal	0.10	13	13.00	0.00
instance n=20 469.alb	1	0	Optimal	0.09	14	14.00	0.00
instance n=20 47.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 470.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 471.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 472.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=20 473.alb	1	0	Optimal	0.11	10	10.00	0.00
instance n=20 474.alb	1	0	Optimal	0.10	14	14.00	0.00
instance n=20 475.alb	1	0	Optimal	0.13	11	11.00	0.00
instance n=20 476.alb	1	0	Optimal	0.08	11	11.00	0.00
instance n=20 477.alb	1	0	Optimal	0.10	11	11.00	0.00
instance n=20 478.alb	1	0	Optimal	0.12	12	12.00	0.00
instance n=20 479.alb	1	0	Optimal	0.10	13	13.00	0.00
instance n=20 48.alb	1	0	Optimal	0.05	5	5.00	0.00
instance n=20 480.alb	1	0	Optimal	0.10	13	13.00	0.00
instance n=20 481.alb	1	0	Optimal	0.10	13	13.00	0.00
instance n=20 482.alb	1	0	Optimal	0.11	13	13.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 483.alb	1	0	Optimal	0.11	12	12.00	0.00
instance n=20 484.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=20 485.alb	1	0	Optimal	0.09	15	15.00	0.00
instance n=20 486.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=20 487.alb	1	0	Optimal	0.10	12	12.00	0.00
instance n=20 488.alb	1	0	Optimal	0.09	15	15.00	0.00
instance n=20 489.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 49.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 490.alb	1	0	Optimal	0.11	12	12.00	0.00
instance n=20 491.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 492.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 493.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 494.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 495.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 496.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 497.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 498.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 499.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 5.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 50.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 500.alb	1	0	Optimal	0.12	8	8.00	0.00
instance n=20 501.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 502.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 503.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 504.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 505.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 506.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 507.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 508.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 509.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 51.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 510.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 511.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 512.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 513.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 514.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 515.alb	1	0	Optimal	0.11	6	6.00	0.00
instance n=20 516.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 517.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 518.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 519.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 52.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 520.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 521.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 522.alb	1	0	Optimal	0.02	3	3.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 523.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 524.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 525.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 53.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 54.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 55.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 56.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 57.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 58.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 59.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 6.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 60.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 61.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=20 62.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 63.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 64.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 65.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 66.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 67.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 68.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 69.alb	1	0	Optimal	0.02	2	2.00	0.00
instance n=20 7.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 70.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 71.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 72.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 73.alb	1	0	Optimal	0.02	2	2.00	0.00
instance n=20 74.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 75.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 76.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 77.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 78.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 79.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 8.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 80.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 81.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 82.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 83.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 84.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 85.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 86.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 87.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 88.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 89.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 9.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 90.alb	1	0	Optimal	0.02	3	3.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 91.alb	1	0	Optimal	0.10	11	11.00	0.00
instance n=20 92.alb	1	0	Optimal	0.11	11	11.00	0.00
instance n=20 93.alb	1	0	Optimal	0.25	13	13.00	0.00
instance n=20 94.alb	1	0	Optimal	0.02	10	10.00	0.00
instance n=20 95.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 96.alb	1	0	Optimal	0.09	10	10.00	0.00
instance n=20 97.alb	1	0	Optimal	1.15	15	15.00	0.00
instance n=20 98.alb	1	0	Optimal	0.25	13	13.00	0.00
instance n=20 99.alb	1	0	Optimal	0.29	12	12.00	0.00
instance n=50 1.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 10.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 100.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 101.alb	1	0	Solution	30.01	30	27.00	10.00
instance n=50 102.alb	1	0	Solution	30.02	32	28.00	12.50
instance n=50 103.alb	1	0	Solution	30.02	29	26.00	10.34
instance n=50 104.alb	1	0	Solution	30.00	27	25.00	7.41
instance n=50 105.alb	1	0	Solution	30.02	24	23.00	4.17
instance n=50 106.alb	1	0	Solution	30.02	28	26.00	7.14
instance n=50 107.alb	1	0	Solution	30.00	28	27.00	3.57
instance n=50 108.alb	1	0	Solution	30.01	30	27.00	10.00
instance n=50 109.alb	1	0	Solution	30.01	30	25.00	16.67
instance n=50 11.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 110.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 111.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 112.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 113.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 114.alb	1	0	Solution	30.02	27	25.00	7.41
instance n=50 115.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 116.alb	1	0	Solution	30.01	32	27.00	15.63
instance n=50 117.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 118.alb	1	0	Solution	30.01	29	27.00	6.90
instance n=50 119.alb	1	0	Optimal	3.42	25	25.00	0.00
instance n=50 12.alb	1	0	Optimal	0.05	6	6.00	0.00
instance n=50 120.alb	1	0	Solution	30.01	27	26.00	3.70
instance n=50 121.alb	1	0	Solution	30.01	32	27.00	15.63
instance n=50 122.alb	1	0	Solution	30.01	29	28.00	3.45
instance n=50 123.alb	1	0	Solution	30.02	32	27.00	15.63
instance n=50 124.alb	1	0	Solution	30.01	29	27.00	6.90
instance n=50 125.alb	1	0	Solution	30.01	33	27.00	18.18
instance n=50 126.alb	1	0	Optimal	0.04	12	12.00	0.00
instance n=50 127.alb	1	0	Optimal	0.02	14	14.00	0.00
instance n=50 128.alb	1	0	Optimal	0.16	12	12.00	0.00
instance n=50 129.alb	1	0	Optimal	0.04	13	13.00	0.00
instance n=50 13.alb	1	0	Optimal	0.05	6	6.00	0.00
instance n=50 130.alb	1	0	Optimal	0.04	13	13.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 131.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 132.alb	1	0	Optimal	0.60	12	12.00	0.00
instance n=50 133.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 134.alb	1	0	Optimal	0.47	14	14.00	0.00
instance n=50 135.alb	1	0	Optimal	0.17	13	13.00	0.00
instance n=50 136.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 137.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 138.alb	1	0	Optimal	0.06	12	12.00	0.00
instance n=50 139.alb	1	0	Optimal	1.34	11	11.00	0.00
instance n=50 14.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 140.alb	1	0	Optimal	0.08	12	12.00	0.00
instance n=50 141.alb	1	0	Optimal	0.06	13	13.00	0.00
instance n=50 142.alb	1	0	Optimal	0.04	11	11.00	0.00
instance n=50 143.alb	1	0	Optimal	0.13	12	12.00	0.00
instance n=50 144.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=50 145.alb	1	0	Optimal	0.10	10	10.00	0.00
instance n=50 146.alb	1	0	Optimal	0.06	13	13.00	0.00
instance n=50 147.alb	1	0	Optimal	0.10	13	13.00	0.00
instance n=50 148.alb	1	0	Optimal	0.04	10	10.00	0.00
instance n=50 149.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 15.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 150.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 151.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 152.alb	1	0	Optimal	0.05	7	7.00	0.00
instance n=50 153.alb	1	0	Optimal	0.24	7	7.00	0.00
instance n=50 154.alb	1	0	Optimal	0.06	8	8.00	0.00
instance n=50 155.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 156.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 157.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 158.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 159.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 16.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 160.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 161.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 162.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 163.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 164.alb	1	0	Optimal	0.05	7	7.00	0.00
instance n=50 165.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 166.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 167.alb	1	0	Optimal	0.20	7	7.00	0.00
instance n=50 168.alb	1	0	Optimal	0.20	8	8.00	0.00
instance n=50 169.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 17.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 170.alb	1	0	Optimal	0.11	7	7.00	0.00
instance n=50 171.alb	1	0	Optimal	0.03	8	8.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 172.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 173.alb	1	0	Optimal	0.11	7	7.00	0.00
instance n=50 174.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 175.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 176.alb	1	0	Solution	30.02	27	25.00	7.41
instance n=50 177.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 178.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 179.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 18.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 180.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 181.alb	1	0	Solution	30.00	29	27.00	6.90
instance n=50 182.alb	1	0	Solution	30.02	27	25.00	7.41
instance n=50 183.alb	1	0	Solution	30.00	29	26.00	10.34
instance n=50 184.alb	1	0	Solution	30.00	38	29.00	23.68
instance n=50 185.alb	1	0	Solution	30.02	27	25.00	7.41
instance n=50 186.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 187.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 188.alb	1	0	Solution	30.01	25	24.00	4.00
instance n=50 189.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 19.alb	1	0	Optimal	0.02	8	8.00	0.00
instance n=50 190.alb	1	0	Solution	29.99	30	26.00	13.33
instance n=50 191.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 192.alb	1	0	Solution	30.01	27	26.00	3.70
instance n=50 193.alb	1	0	Solution	30.00	28	27.00	3.57
instance n=50 194.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 195.alb	1	0	Solution	30.03	28	26.00	7.14
instance n=50 196.alb	1	0	Solution	30.01	27	26.00	3.70
instance n=50 197.alb	1	0	Solution	30.02	28	26.00	7.14
instance n=50 198.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 199.alb	1	0	Solution	30.01	29	27.00	6.90
instance n=50 2.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 20.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 200.alb	1	0	Solution	30.01	25	24.00	4.00
instance n=50 201.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 202.alb	1	0	Optimal	0.08	9	9.00	0.00
instance n=50 203.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=50 204.alb	1	0	Optimal	0.26	10	10.00	0.00
instance n=50 205.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 206.alb	1	0	Optimal	3.34	11	11.00	0.00
instance n=50 207.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=50 208.alb	1	0	Optimal	0.08	13	13.00	0.00
instance n=50 209.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 21.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 210.alb	1	0	Optimal	0.06	13	13.00	0.00
instance n=50 211.alb	1	0	Optimal	0.03	12	12.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 212.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=50 213.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 214.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 215.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 216.alb	1	0	Optimal	0.08	12	12.00	0.00
instance n=50 217.alb	1	0	Optimal	0.31	13	13.00	0.00
instance n=50 218.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 219.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 22.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 220.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 221.alb	1	0	Optimal	0.24	11	11.00	0.00
instance n=50 222.alb	1	0	Optimal	0.04	14	14.00	0.00
instance n=50 223.alb	1	0	Optimal	0.42	11	11.00	0.00
instance n=50 224.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=50 225.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 226.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 227.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 228.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 229.alb	1	0	Optimal	0.04	6	6.00	0.00
instance n=50 23.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 230.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 231.alb	1	0	Optimal	0.06	7	7.00	0.00
instance n=50 232.alb	1	0	Optimal	0.19	7	7.00	0.00
instance n=50 233.alb	1	0	Optimal	0.05	6	6.00	0.00
instance n=50 234.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 235.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 236.alb	1	0	Optimal	0.10	7	7.00	0.00
instance n=50 237.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 238.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 239.alb	1	0	Optimal	0.08	7	7.00	0.00
instance n=50 24.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 240.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 241.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 242.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 243.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 244.alb	1	0	Optimal	0.09	7	7.00	0.00
instance n=50 245.alb	1	0	Optimal	0.06	7	7.00	0.00
instance n=50 246.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 247.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 248.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 249.alb	1	0	Optimal	0.08	7	7.00	0.00
instance n=50 25.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=50 250.alb	1	0	Optimal	0.05	7	7.00	0.00
instance n=50 251.alb	1	0	Solution	30.01	27	26.00	3.70
instance n=50 252.alb	1	0	Solution	30.02	32	28.00	12.50

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 253.alb	1	0	Solution	30.00	28	26.00	7.14
instance n=50 254.alb	1	0	Solution	30.01	30	27.00	10.00
instance n=50 255.alb	1	0	Solution	30.02	29	27.00	6.90
instance n=50 256.alb	1	0	Solution	30.01	30	28.00	6.67
instance n=50 257.alb	1	0	Solution	30.00	33	29.00	12.12
instance n=50 258.alb	1	0	Solution	30.02	28	27.00	3.57
instance n=50 259.alb	1	0	Solution	30.02	31	28.00	9.68
instance n=50 26.alb	1	0	Solution	30.02	27	25.00	7.41
instance n=50 260.alb	1	0	Solution	30.00	29	27.00	6.90
instance n=50 261.alb	1	0	Solution	30.02	28	27.00	3.57
instance n=50 262.alb	1	0	Solution	30.01	31	26.00	16.13
instance n=50 263.alb	1	0	Solution	30.00	29	28.00	3.45
instance n=50 264.alb	1	0	Solution	30.02	27	26.00	3.70
instance n=50 265.alb	1	0	Solution	30.01	27	26.00	3.70
instance n=50 266.alb	1	0	Optimal	22.15	29	29.00	0.00
instance n=50 267.alb	1	0	Solution	30.01	28	27.00	3.57
instance n=50 268.alb	1	0	Solution	30.01	29	27.00	6.90
instance n=50 269.alb	1	0	Optimal	5.27	26	26.00	0.00
instance n=50 27.alb	1	0	Solution	30.01	30	27.00	10.00
instance n=50 270.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 271.alb	1	0	Solution	30.00	31	28.00	9.68
instance n=50 272.alb	1	0	Solution	30.02	27	26.00	3.70
instance n=50 273.alb	1	0	Optimal	29.40	27	27.00	0.00
instance n=50 274.alb	1	0	Solution	30.02	29	27.00	6.90
instance n=50 275.alb	1	0	Optimal	1.92	27	27.00	0.00
instance n=50 276.alb	1	0	Optimal	0.18	12	12.00	0.00
instance n=50 277.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 278.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=50 279.alb	1	0	Optimal	0.01	11	11.00	0.00
instance n=50 28.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 280.alb	1	0	Optimal	0.06	13	13.00	0.00
instance n=50 281.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 282.alb	1	0	Optimal	1.01	12	12.00	0.00
instance n=50 283.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=50 284.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 285.alb	1	0	Optimal	0.17	13	13.00	0.00
instance n=50 286.alb	1	0	Optimal	0.19	11	11.00	0.00
instance n=50 287.alb	1	0	Optimal	0.17	12	12.00	0.00
instance n=50 288.alb	1	0	Optimal	0.10	10	10.00	0.00
instance n=50 289.alb	1	0	Optimal	0.18	11	11.00	0.00
instance n=50 29.alb	1	0	Solution	30.01	29	25.00	13.79
instance n=50 290.alb	1	0	Optimal	0.08	14	14.00	0.00
instance n=50 291.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 292.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 293.alb	1	0	Optimal	0.03	12	12.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 294.alb	1	0	Optimal	0.05	13	13.00	0.00
instance n=50 295.alb	1	0	Optimal	0.30	16	16.00	0.00
instance n=50 296.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 297.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 298.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=50 299.alb	1	0	Optimal	0.58	12	12.00	0.00
instance n=50 3.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 30.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 300.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 301.alb	1	0	Optimal	0.05	6	6.00	0.00
instance n=50 302.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 303.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 304.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 305.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 306.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 307.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 308.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 309.alb	1	0	Optimal	0.09	7	7.00	0.00
instance n=50 31.alb	1	0	Solution	30.00	28	25.00	10.71
instance n=50 310.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 311.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 312.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 313.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 314.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 315.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 316.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 317.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 318.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 319.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 32.alb	1	0	Optimal	2.00	25	25.00	0.00
instance n=50 320.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 321.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 322.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 323.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 324.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 325.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 326.alb	1	0	Solution	30.01	33	28.00	15.15
instance n=50 327.alb	1	0	Solution	30.01	28	25.00	10.71
instance n=50 328.alb	1	0	Solution	30.01	32	28.00	12.50
instance n=50 329.alb	1	0	Solution	30.00	25	24.00	4.00
instance n=50 33.alb	1	0	Solution	30.03	25	24.00	4.00
instance n=50 330.alb	1	0	Solution	30.00	29	25.00	13.79
instance n=50 331.alb	1	0	Solution	30.02	29	27.00	6.90
instance n=50 332.alb	1	0	Solution	30.01	25	24.00	4.00
instance n=50 333.alb	1	0	Solution	30.01	28	26.00	7.14

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 334.alb	1	0	Solution	30.02	29	25.00	13.79
instance n=50 335.alb	1	0	Solution	30.01	27	26.00	3.70
instance n=50 336.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 337.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 338.alb	1	0	Solution	30.00	27	26.00	3.70
instance n=50 339.alb	1	0	Solution	30.02	27	26.00	3.70
instance n=50 34.alb	1	0	Solution	30.01	30	27.00	10.00
instance n=50 340.alb	1	0	Solution	29.99	28	26.00	7.14
instance n=50 341.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 342.alb	1	0	Solution	30.00	28	26.00	7.14
instance n=50 343.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 344.alb	1	0	Solution	30.01	30	27.00	10.00
instance n=50 345.alb	1	0	Solution	30.02	29	27.00	6.90
instance n=50 346.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 347.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 348.alb	1	0	Solution	30.02	30	25.00	16.67
instance n=50 349.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 35.alb	1	0	Solution	30.01	32	27.00	15.63
instance n=50 350.alb	1	0	Solution	30.00	24	23.00	4.17
instance n=50 351.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=50 352.alb	1	0	Optimal	0.58	10	10.00	0.00
instance n=50 353.alb	1	0	Optimal	0.06	13	13.00	0.00
instance n=50 354.alb	1	0	Optimal	26.53	13	13.00	0.00
instance n=50 355.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 356.alb	1	0	Optimal	0.03	15	15.00	0.00
instance n=50 357.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=50 358.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=50 359.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=50 36.alb	1	0	Solution	30.02	31	27.00	12.90
instance n=50 360.alb	1	0	Optimal	0.08	12	12.00	0.00
instance n=50 361.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 362.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=50 363.alb	1	0	Solution	30.00	12	11.00	8.33
instance n=50 364.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 365.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=50 366.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=50 367.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 368.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 369.alb	1	0	Optimal	0.08	12	12.00	0.00
instance n=50 37.alb	1	0	Solution	30.01	32	27.00	15.63
instance n=50 370.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 371.alb	1	0	Optimal	0.41	11	11.00	0.00
instance n=50 372.alb	1	0	Optimal	0.25	10	10.00	0.00
instance n=50 373.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 374.alb	1	0	Optimal	0.03	11	11.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 375.alb	1	0	Optimal	0.16	13	13.00	0.00
instance n=50 376.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 377.alb	1	0	Optimal	0.06	7	7.00	0.00
instance n=50 378.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 379.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 38.alb	1	0	Solution	30.01	31	28.00	9.68
instance n=50 380.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 381.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 382.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 383.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 384.alb	1	0	Optimal	0.17	8	8.00	0.00
instance n=50 385.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 386.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 387.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 388.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 389.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 39.alb	1	0	Solution	30.01	29	26.00	10.34
instance n=50 390.alb	1	0	Optimal	0.19	7	7.00	0.00
instance n=50 391.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 392.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 393.alb	1	0	Optimal	0.05	7	7.00	0.00
instance n=50 394.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 395.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 396.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 397.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 398.alb	1	0	Optimal	0.09	6	6.00	0.00
instance n=50 399.alb	1	0	Optimal	0.27	7	7.00	0.00
instance n=50 4.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 40.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 400.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 401.alb	1	0	Solution	30.00	28	26.00	7.14
instance n=50 402.alb	1	0	Solution	30.00	27	26.00	3.70
instance n=50 403.alb	1	0	Solution	30.00	34	30.00	11.76
instance n=50 404.alb	1	0	Solution	30.02	31	26.00	16.13
instance n=50 405.alb	1	0	Solution	30.00	27	26.00	3.70
instance n=50 406.alb	1	0	Solution	30.01	32	30.00	6.25
instance n=50 407.alb	1	0	Solution	30.02	29	26.00	10.34
instance n=50 408.alb	1	0	Optimal	6.43	26	26.00	0.00
instance n=50 409.alb	1	0	Solution	30.01	33	27.00	18.18
instance n=50 41.alb	1	0	Solution	30.01	26	25.00	3.85
instance n=50 410.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 411.alb	1	0	Solution	30.01	29	28.00	3.45
instance n=50 412.alb	1	0	Optimal	18.72	26	26.00	0.00
instance n=50 413.alb	1	0	Solution	30.01	30	26.00	13.33
instance n=50 414.alb	1	0	Solution	30.01	27	26.00	3.70

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 415.alb	1	0	Solution	30.02	28	26.00	7.14
instance n=50 416.alb	1	0	Solution	30.00	27	26.00	3.70
instance n=50 417.alb	1	0	Solution	30.02	30	27.00	10.00
instance n=50 418.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 419.alb	1	0	Solution	30.02	33	28.00	15.15
instance n=50 42.alb	1	0	Solution	30.01	24	23.00	4.17
instance n=50 420.alb	1	0	Solution	30.01	28	26.00	7.14
instance n=50 421.alb	1	0	Solution	30.01	34	29.00	14.71
instance n=50 422.alb	1	0	Solution	30.01	29	26.00	10.34
instance n=50 423.alb	1	0	Solution	30.01	29	26.00	10.34
instance n=50 424.alb	1	0	Solution	30.01	27	26.00	3.70
instance n=50 425.alb	1	0	Solution	30.01	34	29.00	14.71
instance n=50 426.alb	1	0	Optimal	0.17	11	11.00	0.00
instance n=50 427.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 428.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 429.alb	1	0	Optimal	0.06	11	11.00	0.00
instance n=50 43.alb	1	0	Optimal	1.45	25	25.00	0.00
instance n=50 430.alb	1	0	Optimal	0.14	14	14.00	0.00
instance n=50 431.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=50 432.alb	1	0	Optimal	0.17	12	12.00	0.00
instance n=50 433.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 434.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 435.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=50 436.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 437.alb	1	0	Optimal	0.90	12	12.00	0.00
instance n=50 438.alb	1	0	Optimal	0.66	10	10.00	0.00
instance n=50 439.alb	1	0	Optimal	0.33	12	12.00	0.00
instance n=50 44.alb	1	0	Solution	30.01	25	24.00	4.00
instance n=50 440.alb	1	0	Optimal	1.05	13	13.00	0.00
instance n=50 441.alb	1	0	Optimal	0.04	11	11.00	0.00
instance n=50 442.alb	1	0	Optimal	0.08	12	12.00	0.00
instance n=50 443.alb	1	0	Optimal	0.17	11	11.00	0.00
instance n=50 444.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 445.alb	1	0	Optimal	0.05	12	12.00	0.00
instance n=50 446.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=50 447.alb	1	0	Optimal	0.08	13	13.00	0.00
instance n=50 448.alb	1	0	Optimal	0.99	12	12.00	0.00
instance n=50 449.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 45.alb	1	0	Solution	30.02	25	24.00	4.00
instance n=50 450.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 451.alb	1	0	Optimal	0.05	8	8.00	0.00
instance n=50 452.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 453.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 454.alb	1	0	Optimal	0.09	8	8.00	0.00
instance n=50 455.alb	1	0	Optimal	0.03	6	6.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 456.alb	1	0	Optimal	0.05	8	8.00	0.00
instance n=50 457.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 458.alb	1	0	Optimal	0.06	7	7.00	0.00
instance n=50 459.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 46.alb	1	0	Solution	30.00	28	26.00	7.14
instance n=50 460.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 461.alb	1	0	Optimal	0.06	6	6.00	0.00
instance n=50 462.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 463.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 464.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 465.alb	1	0	Optimal	0.05	8	8.00	0.00
instance n=50 466.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=50 467.alb	1	0	Optimal	0.08	9	9.00	0.00
instance n=50 468.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 469.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 47.alb	1	0	Solution	30.00	28	26.00	7.14
instance n=50 470.alb	1	0	Optimal	0.05	8	8.00	0.00
instance n=50 471.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 472.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 473.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 474.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 475.alb	1	0	Optimal	0.10	6	6.00	0.00
instance n=50 476.alb	1	0	Optimal	0.26	28	28.00	0.00
instance n=50 477.alb	1	0	Optimal	0.99	29	29.00	0.00
instance n=50 478.alb	1	0	Optimal	1.32	32	32.00	0.00
instance n=50 479.alb	1	0	Optimal	0.15	28	28.00	0.00
instance n=50 48.alb	1	0	Solution	30.00	27	26.00	3.70
instance n=50 480.alb	1	0	Optimal	0.19	34	34.00	0.00
instance n=50 481.alb	1	0	Optimal	0.33	28	28.00	0.00
instance n=50 482.alb	1	0	Optimal	0.22	27	27.00	0.00
instance n=50 483.alb	1	0	Optimal	0.87	30	30.00	0.00
instance n=50 484.alb	1	0	Optimal	0.27	32	32.00	0.00
instance n=50 485.alb	1	0	Optimal	0.31	31	31.00	0.00
instance n=50 486.alb	1	0	Optimal	0.19	32	31.00	3.13
instance n=50 487.alb	1	0	Optimal	0.47	31	31.00	0.00
instance n=50 488.alb	1	0	Optimal	0.90	31	31.00	0.00
instance n=50 489.alb	1	0	Optimal	0.78	35	35.00	0.00
instance n=50 49.alb	1	0	Solution	30.00	25	24.00	4.00
instance n=50 490.alb	1	0	Optimal	0.30	29	29.00	0.00
instance n=50 491.alb	1	0	Optimal	9.55	35	35.00	0.00
instance n=50 492.alb	1	0	Optimal	0.91	29	29.00	0.00
instance n=50 493.alb	1	0	Optimal	1.09	30	30.00	0.00
instance n=50 494.alb	1	0	Optimal	0.55	32	32.00	0.00
instance n=50 495.alb	1	0	Optimal	0.50	34	34.00	0.00
instance n=50 496.alb	1	0	Optimal	0.49	29	29.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 497.alb	1	0	Optimal	0.94	30	30.00	0.00
instance n=50 498.alb	1	0	Optimal	0.19	30	30.00	0.00
instance n=50 499.alb	1	0	Optimal	0.25	33	33.00	0.00
instance n=50 5.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 50.alb	1	0	Solution	30.01	27	25.00	7.41
instance n=50 500.alb	1	0	Optimal	0.33	34	34.00	0.00
instance n=50 501.alb	1	0	Optimal	0.08	12	12.00	0.00
instance n=50 502.alb	1	0	Optimal	0.06	10	10.00	0.00
instance n=50 503.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=50 504.alb	1	0	Optimal	0.08	11	11.00	0.00
instance n=50 505.alb	1	0	Optimal	0.10	12	12.00	0.00
instance n=50 506.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 507.alb	1	0	Optimal	0.05	13	13.00	0.00
instance n=50 508.alb	1	0	Optimal	0.09	14	14.00	0.00
instance n=50 509.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 51.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=50 510.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=50 511.alb	1	0	Optimal	0.10	13	13.00	0.00
instance n=50 512.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=50 513.alb	1	0	Optimal	0.05	12	12.00	0.00
instance n=50 514.alb	1	0	Optimal	0.10	12	12.00	0.00
instance n=50 515.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=50 516.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=50 517.alb	1	0	Optimal	0.08	14	14.00	0.00
instance n=50 518.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=50 519.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 52.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 520.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 521.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=50 522.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 523.alb	1	0	Optimal	0.11	11	11.00	0.00
instance n=50 524.alb	1	0	Optimal	0.09	14	14.00	0.00
instance n=50 525.alb	1	0	Optimal	0.09	11	11.00	0.00
instance n=50 53.alb	1	0	Solution	30.01	13	12.00	7.69
instance n=50 54.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 55.alb	1	0	Optimal	0.05	13	13.00	0.00
instance n=50 56.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 57.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 58.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=50 59.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 6.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 60.alb	1	0	Optimal	0.16	12	12.00	0.00
instance n=50 61.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 62.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 63.alb	1	0	Optimal	0.03	12	12.00	0.00

Table 5.1: Results for SALBP-1 Problems (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 64.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=50 65.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 66.alb	1	0	Optimal	0.17	12	12.00	0.00
instance n=50 67.alb	1	0	Optimal	0.25	12	12.00	0.00
instance n=50 68.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 69.alb	1	0	Optimal	0.16	12	12.00	0.00
instance n=50 7.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 70.alb	1	0	Optimal	0.05	10	10.00	0.00
instance n=50 71.alb	1	0	Optimal	0.05	13	13.00	0.00
instance n=50 72.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=50 73.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=50 74.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=50 75.alb	1	0	Optimal	0.41	11	11.00	0.00
instance n=50 76.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 77.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 78.alb	1	0	Optimal	0.06	7	7.00	0.00
instance n=50 79.alb	1	0	Optimal	0.09	8	8.00	0.00
instance n=50 8.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 80.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 81.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 82.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=50 83.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 84.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 85.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 86.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 87.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 88.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 89.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 9.alb	1	0	Optimal	0.03	9	9.00	0.00
instance n=50 90.alb	1	0	Optimal	0.21	7	7.00	0.00
instance n=50 91.alb	1	0	Optimal	0.05	7	7.00	0.00
instance n=50 92.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 93.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 94.alb	1	0	Optimal	0.05	7	7.00	0.00
instance n=50 95.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 96.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 97.alb	1	0	Optimal	0.09	7	7.00	0.00
instance n=50 98.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 99.alb	1	0	Optimal	0.03	7	7.00	0.00

Chapter 6

Test Scheduling Problems

Due to the number of instances given, we only run problems for 30 seconds, some results are still missing. The original instance data was given in Prolog format, we generate a JSON equivalent, which is used as input to create the problems.

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m10r10-1.pl.json	100	10	Solution	30.24	10491	9055.00	13.69
t100m10r10-10.pl.json	100	10	Solution	30.05	9593	8369.00	12.76
t100m10r10-11.pl.json	100	10	Solution	30.06	5317	5100.00	4.08
t100m10r10-12.pl.json	100	10	Solution	30.07	6539	5613.00	14.16
t100m10r10-13.pl.json	100	10	Solution	30.05	6831	6786.00	0.66
t100m10r10-14.pl.json	100	10	Solution	30.04	5775	5257.00	8.97
t100m10r10-15.pl.json	100	10	Solution	30.04	6105	5012.00	17.90
t100m10r10-16.pl.json	100	10	Solution	30.08	12563	11589.00	7.75
t100m10r10-17.pl.json	100	10	Solution	30.09	8954	8114.00	9.38
t100m10r10-18.pl.json	100	10	Solution	30.04	10180	9304.00	8.61
t100m10r10-19.pl.json	100	10	Solution	30.09	9812	8514.00	13.23
t100m10r10-2.pl.json	100	10	Solution	30.07	11593	9807.00	15.41
t100m10r10-20.pl.json	100	10	Solution	30.15	12287	10686.00	13.03
t100m10r10-3.pl.json	100	10	Solution	30.06	6878	6379.00	7.26
t100m10r10-4.pl.json	100	10	Solution	30.11	11041	9111.00	17.48
t100m10r10-5.pl.json	100	10	Solution	30.09	12157	11823.00	2.75
t100m10r10-6.pl.json	100	10	Solution	30.06	11688	10914.00	6.62
t100m10r10-7.pl.json	100	10	Solution	30.05	6435	5732.00	10.92
t100m10r10-8.pl.json	100	10	Solution	30.10	11056	10010.00	9.46
t100m10r10-9.pl.json	100	10	Solution	30.11	9878	7991.00	19.10
t100m10r3-1.pl.json	100	10	Optimal	0.62	8711	8711.00	0.00
t100m10r3-10.pl.json	100	10	Optimal	0.43	8958	8958.00	0.00
t100m10r3-11.pl.json	100	10	Optimal	0.15	9560	9560.00	0.00
t100m10r3-12.pl.json	100	10	Optimal	0.38	7892	7892.00	0.00
t100m10r3-13.pl.json	100	10	Optimal	0.09	10078	10077.00	0.01

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m10r3-14.pl.json	100	10	Optimal	0.36	8681	8681.00	0.00
t100m10r3-15.pl.json	100	10	Optimal	0.17	8810	8810.00	0.00
t100m10r3-16.pl.json	100	10	Optimal	0.47	11182	11182.00	0.00
t100m10r3-17.pl.json	100	10	Optimal	0.74	7534	7534.00	0.00
t100m10r3-18.pl.json	100	10	Solution	30.10	10376	9934.00	4.26
t100m10r3-19.pl.json	100	10	Solution	30.03	7706	6970.00	9.55
t100m10r3-2.pl.json	100	10	Optimal	0.29	7082	7082.00	0.00
t100m10r3-20.pl.json	100	10	Optimal	0.17	9025	9025.00	0.00
t100m10r3-3.pl.json	100	10	Optimal	0.42	10054	10053.00	0.01
t100m10r3-4.pl.json	100	10	Optimal	0.10	13122	13121.00	0.01
t100m10r3-5.pl.json	100	10	Optimal	1.50	7545	7545.00	0.00
t100m10r3-6.pl.json	100	10	Optimal	0.93	7840	7840.00	0.00
t100m10r3-7.pl.json	100	10	Optimal	0.16	11010	11009.00	0.01
t100m10r3-8.pl.json	100	10	Optimal	0.16	9112	9112.00	0.00
t100m10r3-9.pl.json	100	10	Optimal	0.34	8532	8532.00	0.00
t100m10r5-1.pl.json	100	10	Solution	30.04	7304	7300.00	0.05
t100m10r5-10.pl.json	100	10	Optimal	1.42	6972	6972.00	0.00
t100m10r5-11.pl.json	100	10	Solution	30.08	9091	8568.00	5.75
t100m10r5-12.pl.json	100	10	Optimal	0.66	6538	6538.00	0.00
t100m10r5-13.pl.json	100	10	Optimal	0.67	8972	8972.00	0.00
t100m10r5-14.pl.json	100	10	Solution	30.07	10478	10347.00	1.25
t100m10r5-15.pl.json	100	10	Solution	30.05	5762	5647.00	2.00
t100m10r5-16.pl.json	100	10	Solution	30.04	7019	6207.00	11.57
t100m10r5-17.pl.json	100	10	Optimal	0.23	6728	6728.00	0.00
t100m10r5-18.pl.json	100	10	Solution	30.12	8987	8811.00	1.96
t100m10r5-19.pl.json	100	10	Optimal	0.98	8885	8885.00	0.00
t100m10r5-2.pl.json	100	10	Optimal	2.05	9010	9010.00	0.00
t100m10r5-20.pl.json	100	10	Optimal	0.91	7022	7022.00	0.00
t100m10r5-3.pl.json	100	10	Optimal	0.99	8820	8820.00	0.00
t100m10r5-4.pl.json	100	10	Optimal	1.02	10753	10753.00	0.00
t100m10r5-5.pl.json	100	10	Optimal	2.03	6608	6608.00	0.00
t100m10r5-6.pl.json	100	10	Solution	30.06	9452	8456.00	10.54
t100m10r5-7.pl.json	100	10	Solution	30.05	8186	7664.00	6.38
t100m10r5-8.pl.json	100	10	Solution	30.12	11383	10079.00	11.46
t100m10r5-9.pl.json	100	10	Solution	30.05	11649	10683.00	8.29
t100m20r10-1.pl.json	100	20	Solution	30.19	12412	12180.00	1.87
t100m20r10-10.pl.json	100	20	Solution	30.05	12646	10953.00	13.39
t100m20r10-11.pl.json	100	20	Solution	30.09	8687	7289.00	16.09
t100m20r10-12.pl.json	100	20	Solution	30.20	7391	6774.00	8.35
t100m20r10-13.pl.json	100	20	Solution	30.08	9695	9229.00	4.81
t100m20r10-14.pl.json	100	20	Solution	30.16	10027	8652.00	13.71
t100m20r10-15.pl.json	100	20	Solution	30.04	6544	5362.00	18.06
t100m20r10-16.pl.json	100	20	Solution	30.10	9264	8343.00	9.94
t100m20r10-17.pl.json	100	20	Solution	30.15	8611	7381.00	14.28
t100m20r10-18.pl.json	100	20	Optimal	1.74	4843	4843.00	0.00

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m20r10-19.pl.json	100	20	Solution	30.16	12320	11752.00	4.61
t100m20r10-2.pl.json	100	20	Solution	30.14	7740	6890.00	10.98
t100m20r10-20.pl.json	100	20	Solution	30.11	9873	8562.00	13.28
t100m20r10-3.pl.json	100	20	Solution	30.07	7133	6295.00	11.75
t100m20r10-4.pl.json	100	20	Solution	30.21	9510	9052.00	4.82
t100m20r10-5.pl.json	100	20	Solution	30.13	9230	8459.00	8.35
t100m20r10-6.pl.json	100	20	Solution	30.10	8781	7619.00	13.23
t100m20r10-7.pl.json	100	20	Solution	30.18	11313	9767.00	13.67
t100m20r10-8.pl.json	100	20	Solution	30.12	7096	7041.00	0.78
t100m20r10-9.pl.json	100	20	Solution	30.19	10835	10019.00	7.53
t100m20r3-1.pl.json	100	20	Optimal	0.59	6585	6585.00	0.00
t100m20r3-10.pl.json	100	20	Optimal	0.28	8535	8535.00	0.00
t100m20r3-11.pl.json	100	20	Optimal	0.60	9084	9084.00	0.00
t100m20r3-12.pl.json	100	20	Optimal	0.28	9066	9066.00	0.00
t100m20r3-13.pl.json	100	20	Solution	30.09	11412	9974.00	12.60
t100m20r3-14.pl.json	100	20	Optimal	0.54	8786	8786.00	0.00
t100m20r3-15.pl.json	100	20	Optimal	0.27	10205	10204.00	0.01
t100m20r3-16.pl.json	100	20	Optimal	0.28	8856	8856.00	0.00
t100m20r3-17.pl.json	100	20	Optimal	1.30	5451	5451.00	0.00
t100m20r3-18.pl.json	100	20	Optimal	0.51	8752	8752.00	0.00
t100m20r3-19.pl.json	100	20	Solution	30.13	8909	8860.00	0.55
t100m20r3-2.pl.json	100	20	Optimal	0.26	8498	8498.00	0.00
t100m20r3-20.pl.json	100	20	Optimal	0.87	7880	7880.00	0.00
t100m20r3-3.pl.json	100	20	Solution	30.21	12170	11987.00	1.50
t100m20r3-4.pl.json	100	20	Optimal	0.53	12258	12257.00	0.01
t100m20r3-5.pl.json	100	20	Optimal	0.25	11932	11931.00	0.01
t100m20r3-6.pl.json	100	20	Optimal	0.28	8531	8531.00	0.00
t100m20r3-7.pl.json	100	20	Optimal	0.28	6512	6512.00	0.00
t100m20r3-8.pl.json	100	20	Optimal	3.31	10690	10689.00	0.01
t100m20r3-9.pl.json	100	20	Optimal	0.30	8255	8255.00	0.00
t100m20r5-1.pl.json	100	20	Optimal	0.34	9098	9098.00	0.00
t100m20r5-10.pl.json	100	20	Solution	30.04	8340	7964.00	4.51
t100m20r5-11.pl.json	100	20	Solution	30.11	6828	5564.00	18.51
t100m20r5-12.pl.json	100	20	Optimal	3.25	8704	8704.00	0.00
t100m20r5-13.pl.json	100	20	Optimal	0.70	8880	8880.00	0.00
t100m20r5-14.pl.json	100	20	Solution	30.26	10590	9727.00	8.15
t100m20r5-15.pl.json	100	20	Optimal	0.59	8953	8953.00	0.00
t100m20r5-16.pl.json	100	20	Solution	30.15	7864	7594.00	3.43
t100m20r5-17.pl.json	100	20	Solution	30.15	5685	5524.00	2.83
t100m20r5-18.pl.json	100	20	Optimal	1.06	6617	6617.00	0.00
t100m20r5-19.pl.json	100	20	Optimal	0.42	9461	9461.00	0.00
t100m20r5-2.pl.json	100	20	Optimal	0.38	9566	9566.00	0.00
t100m20r5-20.pl.json	100	20	Solution	30.06	11569	10228.00	11.59
t100m20r5-3.pl.json	100	20	Optimal	1.74	9366	9366.00	0.00
t100m20r5-4.pl.json	100	20	Solution	30.07	14108	12456.00	11.71

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m20r5-5.pl.json	100	20	Optimal	0.35	8585	8585.00	0.00
t100m20r5-6.pl.json	100	20	Solution	30.12	7528	6539.00	13.14
t100m20r5-7.pl.json	100	20	Solution	30.13	11254	10099.00	10.26
t100m20r5-8.pl.json	100	20	Optimal	2.49	5812	5812.00	0.00
t100m20r5-9.pl.json	100	20	Solution	30.16	6634	6496.00	2.08
t100m50r10-1.pl.json	100	50	Solution	30.17	7299	6941.00	4.90
t100m50r10-10.pl.json	100	50	Solution	30.23	5201	5108.00	1.79
t100m50r10-11.pl.json	100	50	Solution	30.09	4970	4782.00	3.78
t100m50r10-12.pl.json	100	50	Solution	30.06	9335	9122.00	2.28
t100m50r10-13.pl.json	100	50	Solution	30.26	9759	8828.00	9.54
t100m50r10-14.pl.json	100	50	Solution	30.10	10704	8290.00	22.55
t100m50r10-15.pl.json	100	50	Solution	30.08	8637	7804.00	9.64
t100m50r10-16.pl.json	100	50	Solution	30.14	14087	12381.00	12.11
t100m50r10-17.pl.json	100	50	Solution	30.18	9600	9151.00	4.68
t100m50r10-18.pl.json	100	50	Solution	30.34	7214	7120.00	1.30
t100m50r10-19.pl.json	100	50	Solution	30.18	8559	8059.00	5.84
t100m50r10-2.pl.json	100	50	Solution	30.25	7968	7568.00	5.02
t100m50r10-20.pl.json	100	50	Solution	30.09	8421	7939.00	5.72
t100m50r10-3.pl.json	100	50	Optimal	0.33	6937	6937.00	0.00
t100m50r10-4.pl.json	100	50	Solution	30.16	9952	8525.00	14.34
t100m50r10-5.pl.json	100	50	Optimal	1.35	9859	9859.00	0.00
t100m50r10-6.pl.json	100	50	Solution	30.31	7696	6837.00	11.16
t100m50r10-7.pl.json	100	50	Optimal	1.17	9542	9542.00	0.00
t100m50r10-8.pl.json	100	50	Solution	30.07	10719	9176.00	14.39
t100m50r10-9.pl.json	100	50	Solution	30.07	10411	9375.00	9.95
t100m50r3-1.pl.json	100	50	Optimal	0.46	9937	9937.00	0.00
t100m50r3-10.pl.json	100	50	Solution	30.06	8946	8877.00	0.77
t100m50r3-11.pl.json	100	50	Optimal	1.01	6141	6141.00	0.00
t100m50r3-12.pl.json	100	50	Optimal	0.87	6473	6473.00	0.00
t100m50r3-13.pl.json	100	50	Optimal	0.47	8653	8653.00	0.00
t100m50r3-14.pl.json	100	50	Solution	30.09	13018	12796.00	1.71
t100m50r3-15.pl.json	100	50	Optimal	3.29	9056	9056.00	0.00
t100m50r3-16.pl.json	100	50	Optimal	0.41	8680	8680.00	0.00
t100m50r3-17.pl.json	100	50	Optimal	0.55	8197	8197.00	0.00
t100m50r3-18.pl.json	100	50	Optimal	0.38	9318	9318.00	0.00
t100m50r3-19.pl.json	100	50	Optimal	0.35	12265	12264.00	0.01
t100m50r3-2.pl.json	100	50	Optimal	0.79	11030	11029.00	0.01
t100m50r3-20.pl.json	100	50	Optimal	0.38	7662	7662.00	0.00
t100m50r3-3.pl.json	100	50	Optimal	0.46	5348	5348.00	0.00
t100m50r3-4.pl.json	100	50	Optimal	2.02	7800	7800.00	0.00
t100m50r3-5.pl.json	100	50	Optimal	0.83	4207	4207.00	0.00
t100m50r3-6.pl.json	100	50	Optimal	6.31	10596	10596.00	0.00
t100m50r3-7.pl.json	100	50	Optimal	0.43	7826	7826.00	0.00
t100m50r3-8.pl.json	100	50	Optimal	0.81	7865	7865.00	0.00
t100m50r3-9.pl.json	100	50	Optimal	0.48	7891	7891.00	0.00

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m50r5-1.pl.json	100	50	Optimal	0.78	7926	7926.00	0.00
t100m50r5-10.pl.json	100	50	Solution	30.23	7299	6521.00	10.66
t100m50r5-11.pl.json	100	50	Optimal	1.56	9417	9417.00	0.00
t100m50r5-12.pl.json	100	50	Optimal	3.81	8824	8824.00	0.00
t100m50r5-13.pl.json	100	50	Solution	30.05	10473	9115.00	12.97
t100m50r5-14.pl.json	100	50	Solution	30.33	7503	7134.00	4.92
t100m50r5-15.pl.json	100	50	Solution	30.06	10141	9853.00	2.84
t100m50r5-16.pl.json	100	50	Optimal	0.47	6481	6481.00	0.00
t100m50r5-17.pl.json	100	50	Optimal	0.50	6129	6129.00	0.00
t100m50r5-18.pl.json	100	50	Solution	30.06	9100	8337.00	8.38
t100m50r5-19.pl.json	100	50	Solution	30.20	6762	6356.00	6.00
t100m50r5-2.pl.json	100	50	Optimal	1.00	6651	6651.00	0.00
t100m50r5-20.pl.json	100	50	Solution	30.05	6894	6667.00	3.29
t100m50r5-3.pl.json	100	50	Solution	30.19	7944	7857.00	1.10
t100m50r5-4.pl.json	100	50	Optimal	1.39	8296	8296.00	0.00
t100m50r5-5.pl.json	100	50	Optimal	1.26	9977	9977.00	0.00
t100m50r5-6.pl.json	100	50	Optimal	0.91	8240	8240.00	0.00
t100m50r5-7.pl.json	100	50	Optimal	1.34	10904	10903.00	0.01
t100m50r5-8.pl.json	100	50	Optimal	0.90	8293	8293.00	0.00
t100m50r5-9.pl.json	100	50	Solution	30.06	7879	7622.00	3.26
t20m10r10-1.pl.json	20	10	Optimal	0.07	1337	1337.00	0.00
t20m10r10-10.pl.json	20	10	Optimal	0.05	3882	3882.00	0.00
t20m10r10-11.pl.json	20	10	Optimal	0.06	2002	2002.00	0.00
t20m10r10-12.pl.json	20	10	Optimal	0.31	1257	1257.00	0.00
t20m10r10-13.pl.json	20	10	Optimal	0.06	2110	2110.00	0.00
t20m10r10-14.pl.json	20	10	Optimal	2.43	2546	2546.00	0.00
t20m10r10-15.pl.json	20	10	Optimal	0.05	3344	3344.00	0.00
t20m10r10-16.pl.json	20	10	Optimal	3.87	1643	1643.00	0.00
t20m10r10-17.pl.json	20	10	Optimal	0.43	1069	1069.00	0.00
t20m10r10-18.pl.json	20	10	Optimal	0.04	3041	3041.00	0.00
t20m10r10-19.pl.json	20	10	Optimal	0.04	2422	2422.00	0.00
t20m10r10-2.pl.json	20	10	Optimal	0.05	1819	1819.00	0.00
t20m10r10-20.pl.json	20	10	Optimal	0.05	1595	1595.00	0.00
t20m10r10-3.pl.json	20	10	Solution	30.02	843	771.00	8.54
t20m10r10-4.pl.json	20	10	Optimal	0.04	1396	1396.00	0.00
t20m10r10-5.pl.json	20	10	Optimal	0.05	1710	1710.00	0.00
t20m10r10-6.pl.json	20	10	Optimal	0.03	2434	2434.00	0.00
t20m10r10-7.pl.json	20	10	Optimal	0.41	2696	2696.00	0.00
t20m10r10-8.pl.json	20	10	Optimal	0.03	1329	1329.00	0.00
t20m10r10-9.pl.json	20	10	Optimal	4.48	2933	2933.00	0.00
t20m10r3-1.pl.json	20	10	Optimal	0.05	1876	1876.00	0.00
t20m10r3-10.pl.json	20	10	Optimal	0.05	1652	1652.00	0.00
t20m10r3-11.pl.json	20	10	Optimal	0.04	1640	1640.00	0.00
t20m10r3-12.pl.json	20	10	Optimal	0.03	1758	1758.00	0.00
t20m10r3-13.pl.json	20	10	Optimal	0.03	3099	3099.00	0.00

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t20m10r3-14.pl.json	20	10	Solution	30.01	3891	3520.00	9.53
t20m10r3-15.pl.json	20	10	Optimal	0.05	1433	1433.00	0.00
t20m10r3-16.pl.json	20	10	Optimal	0.04	1564	1564.00	0.00
t20m10r3-17.pl.json	20	10	Optimal	0.04	2321	2321.00	0.00
t20m10r3-18.pl.json	20	10	Solution	30.01	821	746.00	9.14
t20m10r3-19.pl.json	20	10	Optimal	0.09	1236	1236.00	0.00
t20m10r3-2.pl.json	20	10	Optimal	0.05	3258	3258.00	0.00
t20m10r3-20.pl.json	20	10	Optimal	0.04	2168	2168.00	0.00
t20m10r3-3.pl.json	20	10	Optimal	0.03	2255	2255.00	0.00
t20m10r3-4.pl.json	20	10	Optimal	0.03	2707	2707.00	0.00
t20m10r3-5.pl.json	20	10	Optimal	0.05	2381	2381.00	0.00
t20m10r3-6.pl.json	20	10	Optimal	0.03	3043	3043.00	0.00
t20m10r3-7.pl.json	20	10	Optimal	0.05	1738	1738.00	0.00
t20m10r3-8.pl.json	20	10	Optimal	2.74	1278	1278.00	0.00
t20m10r3-9.pl.json	20	10	Optimal	0.04	2874	2874.00	0.00
t20m10r5-1.pl.json	20	10	Optimal	0.04	2586	2586.00	0.00
t20m10r5-10.pl.json	20	10	Optimal	0.05	2260	2260.00	0.00
t20m10r5-11.pl.json	20	10	Optimal	0.03	3487	3487.00	0.00
t20m10r5-12.pl.json	20	10	Optimal	0.03	1559	1559.00	0.00
t20m10r5-13.pl.json	20	10	Optimal	0.22	1457	1457.00	0.00
t20m10r5-14.pl.json	20	10	Optimal	0.06	1141	1141.00	0.00
t20m10r5-15.pl.json	20	10	Optimal	0.18	821	821.00	0.00
t20m10r5-16.pl.json	20	10	Optimal	0.03	2910	2910.00	0.00
t20m10r5-17.pl.json	20	10	Optimal	0.05	2337	2337.00	0.00
t20m10r5-18.pl.json	20	10	Optimal	3.96	2920	2920.00	0.00
t20m10r5-19.pl.json	20	10	Optimal	0.03	1952	1952.00	0.00
t20m10r5-2.pl.json	20	10	Optimal	0.03	1639	1639.00	0.00
t20m10r5-20.pl.json	20	10	Optimal	0.03	2660	2660.00	0.00
t20m10r5-3.pl.json	20	10	Optimal	0.05	1406	1406.00	0.00
t20m10r5-4.pl.json	20	10	Optimal	0.05	2658	2658.00	0.00
t20m10r5-5.pl.json	20	10	Optimal	0.08	794	794.00	0.00
t20m10r5-6.pl.json	20	10	Optimal	0.03	2398	2398.00	0.00
t20m10r5-7.pl.json	20	10	Optimal	0.04	1430	1430.00	0.00
t20m10r5-8.pl.json	20	10	Optimal	0.06	976	976.00	0.00
t20m10r5-9.pl.json	20	10	Optimal	0.04	2953	2953.00	0.00
t30m10r10-1.pl.json	30	10	Optimal	6.81	3344	3344.00	0.00
t30m10r10-10.pl.json	30	10	Solution	30.03	4692	4146.00	11.64
t30m10r10-11.pl.json	30	10	Optimal	0.06	2905	2905.00	0.00
t30m10r10-12.pl.json	30	10	Optimal	0.06	3672	3672.00	0.00
t30m10r10-13.pl.json	30	10	Optimal	0.36	2778	2778.00	0.00
t30m10r10-14.pl.json	30	10	Optimal	2.31	2741	2741.00	0.00
t30m10r10-15.pl.json	30	10	Optimal	0.05	2388	2388.00	0.00
t30m10r10-16.pl.json	30	10	Solution	30.03	4225	3900.00	7.69
t30m10r10-17.pl.json	30	10	Optimal	0.08	1504	1504.00	0.00
t30m10r10-18.pl.json	30	10	Solution	30.03	3287	2730.00	16.95

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t30m10r10-19.pl.json	30	10	Optimal	0.05	3874	3874.00	0.00
t30m10r10-2.pl.json	30	10	Optimal	0.03	3169	3169.00	0.00
t30m10r10-20.pl.json	30	10	Optimal	0.05	2691	2691.00	0.00
t30m10r10-3.pl.json	30	10	Solution	30.01	3360	2851.00	15.15
t30m10r10-4.pl.json	30	10	Optimal	0.06	3452	3452.00	0.00
t30m10r10-5.pl.json	30	10	Optimal	0.05	2785	2785.00	0.00
t30m10r10-6.pl.json	30	10	Solution	30.03	1013	775.00	23.49
t30m10r10-7.pl.json	30	10	Optimal	27.69	3755	3755.00	0.00
t30m10r10-8.pl.json	30	10	Solution	30.02	4613	4160.00	9.82
t30m10r10-9.pl.json	30	10	Optimal	0.03	2770	2770.00	0.00
t30m10r3-1.pl.json	30	10	Optimal	0.05	2901	2901.00	0.00
t30m10r3-10.pl.json	30	10	Optimal	0.04	4829	4829.00	0.00
t30m10r3-11.pl.json	30	10	Optimal	0.04	2584	2584.00	0.00
t30m10r3-12.pl.json	30	10	Optimal	0.03	2130	2130.00	0.00
t30m10r3-13.pl.json	30	10	Optimal	0.03	4253	4253.00	0.00
t30m10r3-14.pl.json	30	10	Optimal	0.17	1393	1393.00	0.00
t30m10r3-15.pl.json	30	10	Optimal	0.03	4149	4149.00	0.00
t30m10r3-16.pl.json	30	10	Optimal	0.05	2027	2027.00	0.00
t30m10r3-17.pl.json	30	10	Optimal	0.05	2975	2975.00	0.00
t30m10r3-18.pl.json	30	10	Optimal	0.05	5477	5477.00	0.00
t30m10r3-19.pl.json	30	10	Solution	30.01	1289	1042.00	19.16
t30m10r3-2.pl.json	30	10	Optimal	0.14	2523	2523.00	0.00
t30m10r3-20.pl.json	30	10	Optimal	0.05	4754	4754.00	0.00
t30m10r3-3.pl.json	30	10	Optimal	0.04	2793	2793.00	0.00
t30m10r3-4.pl.json	30	10	Optimal	0.69	2809	2809.00	0.00
t30m10r3-5.pl.json	30	10	Optimal	0.04	3758	3758.00	0.00
t30m10r3-6.pl.json	30	10	Optimal	0.05	2870	2870.00	0.00
t30m10r3-7.pl.json	30	10	Optimal	0.05	2122	2122.00	0.00
t30m10r3-8.pl.json	30	10	Optimal	0.03	2862	2862.00	0.00
t30m10r3-9.pl.json	30	10	Optimal	0.08	2754	2754.00	0.00
t30m10r5-1.pl.json	30	10	Optimal	0.04	1998	1998.00	0.00
t30m10r5-10.pl.json	30	10	Optimal	0.04	3743	3743.00	0.00
t30m10r5-11.pl.json	30	10	Optimal	0.05	2138	2138.00	0.00
t30m10r5-12.pl.json	30	10	Optimal	0.05	2251	2251.00	0.00
t30m10r5-13.pl.json	30	10	Optimal	0.05	2632	2632.00	0.00
t30m10r5-14.pl.json	30	10	Optimal	0.06	2201	2201.00	0.00
t30m10r5-15.pl.json	30	10	Optimal	0.09	2339	2339.00	0.00
t30m10r5-16.pl.json	30	10	Optimal	0.05	4293	4293.00	0.00
t30m10r5-17.pl.json	30	10	Optimal	0.11	1314	1314.00	0.00
t30m10r5-18.pl.json	30	10	Optimal	0.07	2169	2169.00	0.00
t30m10r5-19.pl.json	30	10	Solution	30.01	1346	1279.00	4.98
t30m10r5-2.pl.json	30	10	Optimal	0.05	2399	2399.00	0.00
t30m10r5-20.pl.json	30	10	Optimal	0.05	1486	1486.00	0.00
t30m10r5-3.pl.json	30	10	Optimal	0.05	2494	2494.00	0.00
t30m10r5-4.pl.json	30	10	Optimal	0.03	3405	3405.00	0.00

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t30m10r5-5.pl.json	30	10	Solution	30.02	5243	4550.00	13.22
t30m10r5-6.pl.json	30	10	Optimal	0.05	2382	2382.00	0.00
t30m10r5-7.pl.json	30	10	Optimal	0.06	2018	2018.00	0.00
t30m10r5-8.pl.json	30	10	Optimal	0.04	3089	3089.00	0.00
t30m10r5-9.pl.json	30	10	Optimal	0.05	3704	3704.00	0.00
t30m20r10-1.pl.json	30	20	Solution	30.03	3702	2850.00	23.01
t30m20r10-10.pl.json	30	20	Optimal	4.79	2508	2508.00	0.00
t30m20r10-11.pl.json	30	20	Solution	30.02	3648	3482.00	4.55
t30m20r10-12.pl.json	30	20	Optimal	0.09	4214	4214.00	0.00
t30m20r10-13.pl.json	30	20	Optimal	15.77	3980	3980.00	0.00
t30m20r10-14.pl.json	30	20	Optimal	13.92	3141	3141.00	0.00
t30m20r10-15.pl.json	30	20	Solution	30.02	4322	3457.00	20.01
t30m20r10-16.pl.json	30	20	Optimal	0.11	4002	4002.00	0.00
t30m20r10-17.pl.json	30	20	Solution	30.02	4161	3363.00	19.18
t30m20r10-18.pl.json	30	20	Optimal	6.32	1992	1992.00	0.00
t30m20r10-19.pl.json	30	20	Solution	30.04	2789	2250.00	19.33
t30m20r10-2.pl.json	30	20	Solution	30.02	3982	3447.00	13.44
t30m20r10-20.pl.json	30	20	Optimal	5.60	2314	2314.00	0.00
t30m20r10-3.pl.json	30	20	Optimal	0.09	2158	2158.00	0.00
t30m20r10-4.pl.json	30	20	Solution	30.03	4040	3217.00	20.37
t30m20r10-5.pl.json	30	20	Optimal	0.09	1237	1237.00	0.00
t30m20r10-6.pl.json	30	20	Solution	30.04	3770	3600.00	4.51
t30m20r10-7.pl.json	30	20	Optimal	0.08	2266	2266.00	0.00
t30m20r10-8.pl.json	30	20	Optimal	2.08	1855	1855.00	0.00
t30m20r10-9.pl.json	30	20	Optimal	3.60	2028	2028.00	0.00
t30m20r3-1.pl.json	30	20	Optimal	0.08	2200	2200.00	0.00
t30m20r3-10.pl.json	30	20	Optimal	0.07	3291	3291.00	0.00
t30m20r3-11.pl.json	30	20	Optimal	0.08	4473	4473.00	0.00
t30m20r3-12.pl.json	30	20	Solution	30.02	5060	4931.00	2.55
t30m20r3-13.pl.json	30	20	Optimal	0.07	3536	3536.00	0.00
t30m20r3-14.pl.json	30	20	Optimal	0.08	3432	3432.00	0.00
t30m20r3-15.pl.json	30	20	Optimal	0.08	3463	3463.00	0.00
t30m20r3-16.pl.json	30	20	Optimal	0.07	3893	3893.00	0.00
t30m20r3-17.pl.json	30	20	Optimal	0.07	1892	1892.00	0.00
t30m20r3-18.pl.json	30	20	Optimal	0.08	2653	2653.00	0.00
t30m20r3-19.pl.json	30	20	Optimal	0.08	3141	3141.00	0.00
t30m20r3-2.pl.json	30	20	Optimal	0.08	1251	1251.00	0.00
t30m20r3-20.pl.json	30	20	Optimal	5.77	2745	2745.00	0.00
t30m20r3-3.pl.json	30	20	Optimal	0.08	3434	3434.00	0.00
t30m20r3-4.pl.json	30	20	Optimal	0.10	2394	2394.00	0.00
t30m20r3-5.pl.json	30	20	Optimal	0.06	3776	3776.00	0.00
t30m20r3-6.pl.json	30	20	Optimal	0.08	2250	2250.00	0.00
t30m20r3-7.pl.json	30	20	Optimal	0.12	1693	1693.00	0.00
t30m20r3-8.pl.json	30	20	Optimal	0.08	4997	4997.00	0.00
t30m20r3-9.pl.json	30	20	Optimal	0.08	4898	4898.00	0.00

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t30m20r5-1.pl.json	30	20	Solution	30.02	3195	2787.00	12.77
t30m20r5-10.pl.json	30	20	Optimal	5.14	2133	2133.00	0.00
t30m20r5-11.pl.json	30	20	Optimal	0.08	3974	3974.00	0.00
t30m20r5-12.pl.json	30	20	Optimal	0.08	2197	2197.00	0.00
t30m20r5-13.pl.json	30	20	Optimal	0.09	2296	2296.00	0.00
t30m20r5-14.pl.json	30	20	Optimal	0.07	3861	3861.00	0.00
t30m20r5-15.pl.json	30	20	Optimal	0.08	2353	2353.00	0.00
t30m20r5-16.pl.json	30	20	Optimal	4.27	2751	2751.00	0.00
t30m20r5-17.pl.json	30	20	Optimal	0.08	3555	3555.00	0.00
t30m20r5-18.pl.json	30	20	Optimal	0.06	2384	2384.00	0.00
t30m20r5-19.pl.json	30	20	Optimal	0.11	2080	2080.00	0.00
t30m20r5-2.pl.json	30	20	Optimal	0.10	1715	1715.00	0.00
t30m20r5-20.pl.json	30	20	Optimal	0.10	4176	4176.00	0.00
t30m20r5-3.pl.json	30	20	Solution	30.05	4528	4037.00	10.84
t30m20r5-4.pl.json	30	20	Optimal	0.09	3083	3083.00	0.00
t30m20r5-5.pl.json	30	20	Optimal	0.08	1969	1969.00	0.00
t30m20r5-6.pl.json	30	20	Optimal	0.08	4250	4250.00	0.00
t30m20r5-7.pl.json	30	20	Optimal	0.08	3036	3036.00	0.00
t30m20r5-8.pl.json	30	20	Optimal	1.55	2834	2834.00	0.00
t30m20r5-9.pl.json	30	20	Optimal	0.10	2343	2343.00	0.00
t40m10r10-1.pl.json	40	10	Optimal	0.11	2514	2514.00	0.00
t40m10r10-10.pl.json	40	10	Optimal	0.08	3557	3557.00	0.00
t40m10r10-11.pl.json	40	10	Solution	30.03	4556	4262.00	6.45
t40m10r10-12.pl.json	40	10	Solution	30.01	5225	4355.00	16.65
t40m10r10-13.pl.json	40	10	Optimal	16.47	2789	2789.00	0.00
t40m10r10-14.pl.json	40	10	Optimal	0.47	1648	1648.00	0.00
t40m10r10-15.pl.json	40	10	Optimal	2.03	1844	1844.00	0.00
t40m10r10-16.pl.json	40	10	Solution	30.02	3749	3380.00	9.84
t40m10r10-17.pl.json	40	10	Optimal	0.14	2363	2363.00	0.00
t40m10r10-18.pl.json	40	10	Optimal	0.06	4973	4973.00	0.00
t40m10r10-19.pl.json	40	10	Optimal	0.06	3181	3181.00	0.00
t40m10r10-2.pl.json	40	10	Optimal	0.20	2350	2350.00	0.00
t40m10r10-20.pl.json	40	10	Solution	30.04	2730	2470.00	9.52
t40m10r10-3.pl.json	40	10	Optimal	0.06	3717	3717.00	0.00
t40m10r10-4.pl.json	40	10	Optimal	0.08	3414	3414.00	0.00
t40m10r10-5.pl.json	40	10	Optimal	5.68	2852	2852.00	0.00
t40m10r10-6.pl.json	40	10	Solution	30.02	3262	2910.00	10.79
t40m10r10-7.pl.json	40	10	Optimal	0.08	4572	4572.00	0.00
t40m10r10-8.pl.json	40	10	Solution	30.03	3776	3385.00	10.35
t40m10r10-9.pl.json	40	10	Optimal	0.11	2524	2524.00	0.00
t40m10r3-1.pl.json	40	10	Optimal	0.09	4832	4832.00	0.00
t40m10r3-10.pl.json	40	10	Optimal	0.15	2442	2442.00	0.00
t40m10r3-11.pl.json	40	10	Optimal	0.06	3218	3218.00	0.00
t40m10r3-12.pl.json	40	10	Optimal	0.06	3863	3863.00	0.00
t40m10r3-13.pl.json	40	10	Optimal	0.07	3564	3564.00	0.00

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t40m10r3-14.pl.json	40	10	Optimal	0.08	4913	4913.00	0.00
t40m10r3-15.pl.json	40	10	Optimal	0.26	3785	3785.00	0.00
t40m10r3-16.pl.json	40	10	Optimal	0.11	2840	2840.00	0.00
t40m10r3-17.pl.json	40	10	Optimal	0.06	5506	5506.00	0.00
t40m10r3-18.pl.json	40	10	Optimal	0.08	3848	3848.00	0.00
t40m10r3-19.pl.json	40	10	Optimal	0.11	2259	2259.00	0.00
t40m10r3-2.pl.json	40	10	Solution	30.04	1727	1589.00	7.99
t40m10r3-20.pl.json	40	10	Optimal	0.09	4157	4157.00	0.00
t40m10r3-3.pl.json	40	10	Optimal	0.08	4903	4903.00	0.00
t40m10r3-4.pl.json	40	10	Solution	30.03	1635	1341.00	17.98
t40m10r3-5.pl.json	40	10	Optimal	0.16	1984	1984.00	0.00
t40m10r3-6.pl.json	40	10	Optimal	0.06	5005	5005.00	0.00
t40m10r3-7.pl.json	40	10	Solution	30.03	5545	5188.00	6.44
t40m10r3-8.pl.json	40	10	Optimal	0.08	3658	3658.00	0.00
t40m10r3-9.pl.json	40	10	Optimal	0.19	3830	3830.00	0.00
t40m10r5-1.pl.json	40	10	Optimal	0.08	4857	4857.00	0.00
t40m10r5-10.pl.json	40	10	Optimal	0.08	3989	3989.00	0.00
t40m10r5-11.pl.json	40	10	Optimal	0.08	5238	5238.00	0.00
t40m10r5-12.pl.json	40	10	Optimal	0.08	4584	4584.00	0.00
t40m10r5-13.pl.json	40	10	Optimal	0.09	2307	2307.00	0.00
t40m10r5-14.pl.json	40	10	Optimal	0.30	1826	1826.00	0.00
t40m10r5-15.pl.json	40	10	Optimal	0.11	1926	1926.00	0.00
t40m10r5-16.pl.json	40	10	Optimal	0.11	5216	5216.00	0.00
t40m10r5-17.pl.json	40	10	Optimal	0.08	7162	7162.00	0.00
t40m10r5-18.pl.json	40	10	Optimal	0.11	4892	4892.00	0.00
t40m10r5-19.pl.json	40	10	Optimal	0.08	4027	4027.00	0.00
t40m10r5-2.pl.json	40	10	Optimal	8.38	4099	4099.00	0.00
t40m10r5-20.pl.json	40	10	Solution	30.02	4899	4755.00	2.94
t40m10r5-3.pl.json	40	10	Optimal	0.08	3113	3113.00	0.00
t40m10r5-4.pl.json	40	10	Optimal	0.10	6626	6626.00	0.00
t40m10r5-5.pl.json	40	10	Optimal	0.08	3828	3828.00	0.00
t40m10r5-6.pl.json	40	10	Optimal	0.09	4213	4213.00	0.00
t40m10r5-7.pl.json	40	10	Optimal	0.28	4303	4303.00	0.00
t40m10r5-8.pl.json	40	10	Solution	30.03	3559	3189.00	10.40
t40m10r5-9.pl.json	40	10	Optimal	0.41	1953	1953.00	0.00
t40m20r10-1.pl.json	40	20	Solution	30.09	4518	3972.00	12.08
t40m20r10-10.pl.json	40	20	Optimal	12.43	3862	3862.00	0.00
t40m20r10-11.pl.json	40	20	Optimal	0.14	1952	1952.00	0.00
t40m20r10-12.pl.json	40	20	Optimal	0.14	4129	4129.00	0.00
t40m20r10-13.pl.json	40	20	Optimal	0.28	2927	2927.00	0.00
t40m20r10-14.pl.json	40	20	Solution	30.05	2701	2381.00	11.85
t40m20r10-15.pl.json	40	20	Optimal	11.77	3168	3168.00	0.00
t40m20r10-16.pl.json	40	20	Optimal	0.14	2812	2812.00	0.00
t40m20r10-17.pl.json	40	20	Solution	30.07	4288	3718.00	13.29
t40m20r10-18.pl.json	40	20	Solution	30.05	3611	3194.00	11.55

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t40m20r10-19.pl.json	40	20	Optimal	12.23	2891	2891.00	0.00
t40m20r10-2.pl.json	40	20	Optimal	8.74	3284	3284.00	0.00
t40m20r10-20.pl.json	40	20	Solution	30.04	5506	4945.00	10.19
t40m20r10-3.pl.json	40	20	Solution	30.08	5981	5478.00	8.41
t40m20r10-4.pl.json	40	20	Optimal	0.14	3409	3409.00	0.00
t40m20r10-5.pl.json	40	20	Solution	30.06	5113	4278.00	16.33
t40m20r10-6.pl.json	40	20	Solution	30.03	2376	2333.00	1.81
t40m20r10-7.pl.json	40	20	Solution	30.06	4799	4243.00	11.59
t40m20r10-8.pl.json	40	20	Solution	30.02	3924	3327.00	15.21
t40m20r10-9.pl.json	40	20	Optimal	3.86	2043	2043.00	0.00
t40m20r3-1.pl.json	40	20	Optimal	0.16	3524	3524.00	0.00
t40m20r3-10.pl.json	40	20	Optimal	0.19	3110	3110.00	0.00
t40m20r3-11.pl.json	40	20	Optimal	0.15	3695	3695.00	0.00
t40m20r3-12.pl.json	40	20	Optimal	0.24	4828	4828.00	0.00
t40m20r3-13.pl.json	40	20	Optimal	0.25	4010	4010.00	0.00
t40m20r3-14.pl.json	40	20	Optimal	0.14	2752	2752.00	0.00
t40m20r3-15.pl.json	40	20	Optimal	0.16	3312	3312.00	0.00
t40m20r3-16.pl.json	40	20	Optimal	0.16	4304	4304.00	0.00
t40m20r3-17.pl.json	40	20	Optimal	0.17	3991	3991.00	0.00
t40m20r3-18.pl.json	40	20	Optimal	0.17	5733	5733.00	0.00
t40m20r3-19.pl.json	40	20	Optimal	0.17	3581	3581.00	0.00
t40m20r3-2.pl.json	40	20	Optimal	0.17	4869	4869.00	0.00
t40m20r3-20.pl.json	40	20	Optimal	0.17	3514	3514.00	0.00
t40m20r3-3.pl.json	40	20	Optimal	0.24	2503	2503.00	0.00
t40m20r3-4.pl.json	40	20	Optimal	0.13	4323	4323.00	0.00
t40m20r3-5.pl.json	40	20	Optimal	0.17	3626	3626.00	0.00
t40m20r3-6.pl.json	40	20	Optimal	0.17	2488	2488.00	0.00
t40m20r3-7.pl.json	40	20	Optimal	0.17	3470	3470.00	0.00
t40m20r3-8.pl.json	40	20	Optimal	0.24	6730	6730.00	0.00
t40m20r3-9.pl.json	40	20	Optimal	0.20	4656	4656.00	0.00
t40m20r5-1.pl.json	40	20	Optimal	0.28	1318	1318.00	0.00
t40m20r5-10.pl.json	40	20	Optimal	0.25	2216	2216.00	0.00
t40m20r5-11.pl.json	40	20	Optimal	0.25	3538	3538.00	0.00
t40m20r5-12.pl.json	40	20	Optimal	0.23	5346	5346.00	0.00
t40m20r5-13.pl.json	40	20	Solution	30.03	4589	4393.00	4.27
t40m20r5-14.pl.json	40	20	Optimal	0.17	2243	2243.00	0.00
t40m20r5-15.pl.json	40	20	Solution	30.08	3869	3590.00	7.21
t40m20r5-16.pl.json	40	20	Optimal	0.17	4319	4319.00	0.00
t40m20r5-17.pl.json	40	20	Optimal	0.18	4866	4866.00	0.00
t40m20r5-18.pl.json	40	20	Optimal	0.39	5802	5802.00	0.00
t40m20r5-19.pl.json	40	20	Solution	30.06	4197	4072.00	2.98
t40m20r5-2.pl.json	40	20	Optimal	0.16	2634	2634.00	0.00
t40m20r5-20.pl.json	40	20	Solution	30.03	6482	6232.00	3.86
t40m20r5-3.pl.json	40	20	Optimal	0.19	4391	4391.00	0.00
t40m20r5-4.pl.json	40	20	Optimal	9.64	4610	4610.00	0.00

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t40m20r5-5.pl.json	40	20	Optimal	0.17	3105	3105.00	0.00
t40m20r5-6.pl.json	40	20	Optimal	0.16	4760	4760.00	0.00
t40m20r5-7.pl.json	40	20	Optimal	0.31	1218	1218.00	0.00
t40m20r5-8.pl.json	40	20	Solution	30.05	2601	2190.00	15.80
t40m20r5-9.pl.json	40	20	Optimal	0.19	3141	3141.00	0.00
t500m100r10-10.pl.json	500	100	Solution	30.54	43793	795.00	98.18
t500m100r10-11.pl.json	500	100	Solution	30.92	36367	801.00	97.80
t500m100r10-13.pl.json	500	100	Solution	30.63	45030	801.00	98.22
t500m100r10-14.pl.json	500	100	Solution	30.54	40089	800.00	98.00
t500m100r10-15.pl.json	500	100	Solution	30.45	41425	801.00	98.07
t500m100r10-16.pl.json	500	100	Solution	30.65	40463	801.00	98.02
t500m100r10-17.pl.json	500	100	Solution	30.43	33209	798.00	97.60
t500m100r10-18.pl.json	500	100	Solution	30.44	41028	801.00	98.05
t500m100r10-19.pl.json	500	100	Solution	30.94	49137	801.00	98.37
t500m100r10-2.pl.json	500	100	Solution	30.54	42142	796.00	98.11
t500m100r10-20.pl.json	500	100	Solution	30.35	38167	801.00	97.90
t500m100r10-3.pl.json	500	100	Solution	30.39	37653	801.00	97.87
t500m100r10-4.pl.json	500	100	Solution	30.67	39921	798.00	98.00
t500m100r10-5.pl.json	500	100	Solution	30.47	35252	800.00	97.73
t500m100r10-6.pl.json	500	100	Solution	30.65	41172	801.00	98.05
t500m100r10-7.pl.json	500	100	Solution	30.97	41044	800.00	98.05
t500m100r10-8.pl.json	500	100	Solution	30.52	46351	800.00	98.27
t500m100r10-9.pl.json	500	100	Solution	30.51	40539	800.00	98.03
t500m100r3-1.pl.json	500	100	Solution	30.55	39303	801.00	97.96
t500m100r3-10.pl.json	500	100	Solution	30.65	42052	801.00	98.10
t500m100r3-11.pl.json	500	100	Solution	30.62	38084	794.00	97.92
t500m100r3-12.pl.json	500	100	Solution	30.70	38483	800.00	97.92
t500m100r3-13.pl.json	500	100	Solution	30.57	35447	801.00	97.74
t500m100r3-14.pl.json	500	100	Solution	30.42	40571	798.00	98.03
t500m100r3-15.pl.json	500	100	Solution	30.45	38987	801.00	97.95
t500m100r3-16.pl.json	500	100	Solution	30.59	41984	798.00	98.10
t500m100r3-18.pl.json	500	100	Solution	30.89	39919	801.00	97.99
t500m100r3-19.pl.json	500	100	Optimal	10.63	41896	41892.00	0.01
t500m100r3-2.pl.json	500	100	Optimal	10.86	41211	41207.00	0.01
t500m100r3-20.pl.json	500	100	Solution	30.78	38551	800.00	97.92
t500m100r3-3.pl.json	500	100	Solution	30.79	35516	798.00	97.75
t500m100r3-4.pl.json	500	100	Solution	30.36	32084	798.00	97.51
t500m100r3-5.pl.json	500	100	Solution	30.66	38761	801.00	97.93
t500m100r3-6.pl.json	500	100	Solution	30.52	46048	800.00	98.26
t500m100r3-7.pl.json	500	100	Solution	30.45	37680	800.00	97.88
t500m100r3-8.pl.json	500	100	Solution	30.69	40838	799.00	98.04
t500m100r3-9.pl.json	500	100	Solution	30.85	44803	801.00	98.21
t500m100r5-1.pl.json	500	100	Solution	30.49	36936	797.00	97.84
t500m100r5-10.pl.json	500	100	Solution	31.15	30332	800.00	97.36
t500m100r5-11.pl.json	500	100	Solution	30.80	37660	801.00	97.87

Table 6.1: Results for Test Scheduling Problems (544 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m100r5-12.pl.json	500	100	Solution	30.42	39090	799.00	97.96
t500m100r5-13.pl.json	500	100	Solution	30.39	44171	801.00	98.19
t500m100r5-14.pl.json	500	100	Solution	30.45	39568	800.00	97.98
t500m100r5-15.pl.json	500	100	Solution	30.57	38257	800.00	97.91
t500m100r5-16.pl.json	500	100	Solution	30.61	35151	798.00	97.73
t500m100r5-17.pl.json	500	100	Solution	30.72	39749	797.00	97.99
t500m100r5-18.pl.json	500	100	Solution	30.54	45868	801.00	98.25
t500m100r5-19.pl.json	500	100	Solution	30.40	46018	801.00	98.26
t500m100r5-2.pl.json	500	100	Solution	30.58	43708	800.00	98.17
t500m100r5-20.pl.json	500	100	Solution	30.82	39466	800.00	97.97
t500m100r5-3.pl.json	500	100	Solution	30.77	42468	801.00	98.11
t500m100r5-4.pl.json	500	100	Solution	30.57	33936	801.00	97.64
t500m100r5-5.pl.json	500	100	Solution	30.69	38103	795.00	97.91
t500m100r5-6.pl.json	500	100	Solution	30.62	45271	801.00	98.23
t500m100r5-7.pl.json	500	100	Solution	30.68	43542	800.00	98.16
t500m100r5-8.pl.json	500	100	Solution	30.74	38116	796.00	97.91
t500m100r5-9.pl.json	500	100	Solution	30.43	39282	801.00	97.96
t500m10r10-1.pl.json	500	10	Solution	30.06	48213	42756.00	11.32
t500m10r10-10.pl.json	500	10	Solution	30.08	35490	30745.00	13.37
t500m10r10-11.pl.json	500	10	Solution	30.10	47651	42832.00	10.11
t500m10r10-12.pl.json	500	10	Solution	30.09	43253	35908.00	16.98

Chapter 7

J&J Hybrid Flexible Flowshop with Transportation Times

7.1 Without Transportation Times