Results for Scheduling Benchmark Classes

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November 15, 2024

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, and CPSat 9.11, both using their Java API.

Chapter 2

Overview

The following tables compare the results of CPOptimizer and CPSat on a number of well-known benchmark problems. Note that the programs used are the generic solutions of the problems, there was no attempt to improve lower bounds, or add redundant constraints that would improve pruning for a specific problem class. As such, the results indicate "out-of-the-box" performance of the solvers.

The comparison does not attempt to compare the solutions found to the best known results, it is only intended to compare the results of the solvers considered based on the same underlying data model, running on the same hardware, with the same time limit.

Table 2.1 shows the results for the Taillard open shop problem set. All problems are solved to optimality by both solvers, given 600 seconds timeout and 4 resp. 8 threads for the solver. The results are grouped by instances classes where x/y indicate x jobs on y machines. We compare the time taken to find and prove the optimal solution based on the virtual best solution of the faster time of the solvers. For smaller instances, CPSat seems to be faster, but for larger instances CPOptimizer finds the solution more rapidly. Given that all results are obtained in atmost a few seconds on either solver, this does not seem to be a significant difference.

Table 2.1: Comparison of CPO and CPSat for Result Groups of Taillard Open-Shop Problems

		All Instances				Optimal Only		Non Optimal Only			
		Optimal (% of All Instances)				Time (% of VB)		Cost (% of VB)		Bound (% of VB)	
Group	Nr	Both	CPO	CPSat	None	CPO	CPSat	CPO	CPSat	CPO	CPSat
4/4	10	100.00	0.00	0.00	0.00	639.09	100.00	n/a	n/a	n/a	n/a
5/5	10	100.00	0.00	0.00	0.00	217.83	100.00	n/a	n/a	n/a	n/a
7/7	10	100.00	0.00	0.00	0.00	206.25	106.99	n/a	n/a	n/a	n/a
10/10	10	100.00	0.00	0.00	0.00	119.36	150.15	n/a	n/a	n/a	n/a
15/15	10	100.00	0.00	0.00	0.00	100.00	288.65	n/a	n/a	n/a	n/a
20/20	10	100.00	0.00	0.00	0.00	114.30	207.41	n/a	n/a	n/a	n/a

Table 2.2 compares the results for the Taillard job shop problems (incomplete). Only some of the problem groups are solved to optimality. For the 10/20 set, CPOptimizer proves optimality, while CPSat finds solutions which are very close to the optimal results. The bound results for 100/20 with CPSat are incorrect, and need to be recomputed.

Table 2.2: Comparison of CPO and CPSat for Result Groups of Taillard Job-Shop Problems

		All Instances				Optimal Only		Non Optimal Only			
		Optimal (% of All Instances)				Time (% of VB)		Cost (% of VB)		Bound (% of VB)	
Group	Nr	Both	CPO	CPSat	None	CPO	CPSat	CPO	CPSat	CPO	CPSat
15/15	10	90.00	0.00	0.00	10.00	105.19	141.18	100.00	100.00	97.17	100.00
20/15	10	20.00	0.00	0.00	80.00	267.27	263.20	100.99	100.05	98.50	99.93
20/20	10	0.00	0.00	0.00	100.00	n/a	n/a	100.74	100.06	97.96	100.00
30/15	10	10.00	0.00	10.00	80.00	174.32	100.00	100.18	100.49	99.87	100.00
30/20	10	0.00	0.00	0.00	100.00	n/a	n/a	100.30	101.30	99.40	100.00
50/15	10	100.00	0.00	0.00	0.00	100.00	685.09	n/a	n/a	n/a	n/a
50/20	10	10.00	60.00	0.00	30.00	100.00	381.38	100.00	101.60	100.00	100.00
100/20	10	10.00	90.00	0.00	0.00	100.00	416.13	100.00	101.73	100.00	66.81

Table 2.3: Comparison of CPO and CPSat for Result Groups of Taillard Flow-Shop Problems

		All Instances				Optimal Only		Non Optimal Only			
		Optimal (% of All Instances)				Time (% of VB)		Cost (% of VB)		Bound (% of VB)	
Group	Nr	Both	CPO	CPSat	None	CPO	CPSat	CPO	CPSat	CPO	CPSat
20/5	10	100.00	0.00	0.00	0.00	203.99	101.36	n/a	n/a	n/a	n/a
20/10	10	10.00	0.00	10.00	80.00	415.20	100.00	100.54	100.19	100.00	98.52
20/20	10	0.00	0.00	0.00	100.00	n/a	n/a	102.07	100.19	100.00	96.83
50/5	10	100.00	0.00	0.00	0.00	317.33	101.91	n/a	n/a	n/a	n/a
50/10	10	0.00	0.00	0.00	100.00	n/a	n/a	103.31	100.00	100.00	99.49
50/20	10	0.00	0.00	0.00	100.00	n/a	n/a	105.18	100.00	100.00	99.27
100/5	10	0.00	0.00	70.00	30.00	n/a	n/a	100.49	100.00	99.98	99.98
100/10	10	0.00	0.00	0.00	100.00	n/a	n/a	107.11	100.00	100.00	99.91
100/20	10	0.00	0.00	0.00	100.00	n/a	n/a	107.94	100.00	100.00	99.76
200/10	10	0.00	0.00	0.00	100.00	n/a	n/a	108.32	100.00	100.00	99.97
200/20	10	0.00	0.00	0.00	100.00	n/a	n/a	105.86	100.00	99.98	99.98
500/20	10	0.00	0.00	0.00	100.00	n/a	n/a	106.46	100.00	52.45	100.00

Table 2.3 shows the results for the Taillard flow shop problems. Instance sets 20/5 and 50/5 are solved to optimality by both solvers, CPOptimizer finds many optimal solutions for the 100/5 sets. There are a few optimal solutions for the 20/10 set as well. Execution times for the optimal solutions seems to be significantly higher for CPSat. Comparing the non-optimal solutions, CPOptimizer consistently finds better solutions, but on average, CPSat is within 10% of the CPOptimizer result. For the bounds, CPSat often provide slightly better lower bounds, but CPOptimizer results are pretty close. Note that for the bounds, a higher value is better, so achieving 100% of the virtual best bound is better than achieving 98%.

Table 2.4 compares the results for CPOptimizer for the regular flow shop and the permutation flow shop version on the same data. The model for the permutation flow shop is not available with CPSat. A number of instances are solved to optimality with the permutation flow shop variant, but these optimal solutions typically are not optimal for the unrestricted version. In general, it is much faster to find the optimal solution for the permutation flowshop version, and perhaps surprisingly, the results for the non-optimal instances are often superior for the permutation flowshop. The bounds for the permutation flowshop are stronger, but they are not valid bounds for the unrestricted version.

Table 2.4: Comparison of CPO for Result Groups of Permutation and Unrestricted FlowShop Problems

		All Instances				Optimal Only		Non Optimal Only			
		Optimal (% of All Instances)				Time (% of VB)		Cost (% of VB)		Bound (% of VB)	
Group	Nr	Both	FSS	PFSS	None	FSS	PFSS	FSS	PFSS	FSS	PFSS
20/5	10	100.00	0.00	0.00	0.00	188.74	100.00	n/a	n/a	n/a	n/a
20/10	10	20.00	0.00	50.00	30.00	212.55	100.00	100.13	101.25	96.28	99.90
20/20	10	0.00	0.00	0.00	100.00	n/a	n/a	100.00	101.33	98.44	99.87
50/5	10	100.00	0.00	0.00	0.00	494.74	107.07	n/a	n/a	n/a	n/a
50/10	10	0.00	0.00	10.00	90.00	n/a	n/a	100.97	100.02	99.44	100.00
50/20	10	0.00	0.00	0.00	100.00	n/a	n/a	102.96	100.00	99.27	100.00
100/5	10	70.00	0.00	30.00	0.00	910.13	100.00	100.22	100.00	99.83	100.00
100/10	10	0.00	0.00	0.00	100.00	n/a	n/a	101.47	100.00	99.75	100.00
100/20	10	0.00	0.00	0.00	100.00	n/a	n/a	104.64	100.00	99.53	100.00
200/10	10	0.00	0.00	0.00	100.00	n/a	n/a	102.82	100.00	99.89	100.00
200/20	10	0.00	0.00	0.00	100.00	n/a	n/a	105.11	100.00	99.62	100.00
500/20	10	0.00	0.00	0.00	100.00	n/a	n/a	100.03	100.70	99.88	100.00

Table 2.5: Comparison of CPO and CPSat for Result Groups of SALBP-1 Problems

		All Instances				Optimal Only		Non Optimal Only			
		Optimal (% of All Instances)				Time (% of VB)		Cost (% of VB)		Bound (% of VB)	
Group	Nr	Both	CPO	CPSat	None	CPO	CPSat	CPO	CPSat	CPO	CPSat
20	525	99.62	0.00	0.38	0.00	1079.77	134.05	100.00	100.00	82.14	100.00
50	525	43.81	28.95	15.81	11.43	327.51	938.89	100.16	100.04	95.96	71.28
100	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1000	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

The results (incomplete) for SALBP-1 in Table 2.5 were obtained with a 30 second timeout. All of the 20 task instances were solved to optimality (some only with CPSat), while 88% of the 50 task instances were solved to optimality, but only 43% were solved by both. The time taken to find the common optimal solutions varies significantly, CPSat seems on average faster on the small

instances, while CPOptimizer is faster on a larger instances, but this does not hold for all instances. For the non-optimal solutions, solution quality seems very evenly balanced.

Table 2.6: Comparison of CPO and CPSat for Result Groups of Test Scheduling Problems

		All Instances				Optimal Only		Non Optimal Only			
		Optimal (% of All Instances)				Time (% of VB)		Cost (% of VB)		Bound (% of VB)	
Group	Nr	Both	CPO	CPSat	None	CPO	CPSat	CPO	CPSat	CPO	CPSat
20/10/3	20	90.00	0.00	5.00	5.00	393.93	133.28	100.00	100.00	92.00	100.00
20/10/5	20	100.00	0.00	0.00	0.00	294.88	117.68	n/a	n/a	n/a	n/a
20/10/10	20	95.00	0.00	0.00	5.00	501.45	107.85	100.00	100.00	100.00	100.00
30/10/3	20	95.00	0.00	0.00	5.00	100.48	183.16	100.08	100.00	100.00	100.00
30/10/5	20	90.00	0.00	5.00	5.00	100.00	205.76	100.00	100.00	89.37	100.00
30/10/10	20	70.00	0.00	15.00	15.00	382.57	104.61	100.01	100.00	93.29	100.00
30/20/3	20	95.00	0.00	5.00	0.00	205.53	144.45	100.00	100.00	97.45	100.00
30/20/5	20	90.00	0.00	10.00	0.00	229.19	132.32	100.00	100.00	88.36	100.00
30/20/10	20	60.00	0.00	30.00	10.00	439.18	104.94	100.00	100.00	89.44	100.00
40/10/3	20	85.00	0.00	0.00	15.00	104.79	280.75	100.02	100.02	100.00	100.00
40/10/5	20	90.00	0.00	5.00	5.00	194.05	150.11	100.00	100.00	98.22	100.00
40/10/10	20	70.00	0.00	20.00	10.00	231.87	109.84	100.00	100.00	93.80	100.00
40/20/3	20	100.00	0.00	0.00	0.00	100.19	172.54	n/a	n/a	n/a	n/a
40/20/5	20	75.00	0.00	20.00	5.00	154.81	109.98	100.00	100.00	95.30	100.00
40/20/10	20	50.00	0.00	35.00	15.00	285.15	106.26	100.00	100.00	92.51	100.00
50/10/3	20	85.00	0.00	0.00	15.00	466.49	100.00	100.00	100.00	100.00	100.00
50/10/5	20	45.00	0.00	10.00	45.00	682.15	100.00	100.00	100.00	99.31	100.00
50/10/10	20	15.00	0.00	30.00	55.00	1381.55	100.00	100.00	100.00	98.26	100.00
50/20/3	20	90.00	0.00	10.00	0.00	726.25	100.00	100.00	100.00	94.42	100.00
50/20/5	20	60.00	0.00	0.00	40.00	573.69	100.00	100.00	100.00	100.00	100.00
50/20/10	20	35.00	0.00	10.00	55.00	671.58	100.00	100.00	100.00	94.08	100.00
100/10/3	20	90.00	0.00	0.00	10.00	100.00	1998.93	100.00	100.00	100.00	100.00
100/10/5	20	45.00	5.00	0.00	50.00	100.00	1105.69	100.00	100.14	100.00	100.00
100/10/10	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	100.23	100.00	100.00
100/20/3	20	85.00	0.00	0.00	15.00	100.00	1552.40	100.00	100.12	100.00	100.00
100/20/5	20	35.00	15.00	0.00	50.00	100.00	2147.25	100.00	100.75	100.00	100.00
100/20/10	20	5.00	0.00	0.00	95.00	100.00	903.53	100.00	100.83	100.00	100.00
100/50/3	20	80.00	10.00	0.00	10.00	100.00	1410.06	100.00	100.78	100.00	100.00
100/50/5	20	45.00	10.00	0.00	45.00	100.00	805.32	100.00	100.11	100.00	100.00
100/50/10	20	10.00	5.00	0.00	85.00	100.00	1260.03	100.00	100.63	100.00	100.00
500/10/3	20	0.00	5.00	0.00	95.00	n/a	n/a	100.00	227.86	16.72	100.00
500/10/5	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	226.47	2.06	100.00
500/10/10	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	226.89	27.57	100.00
500/20/3	20	0.00	20.00	0.00	80.00	n/a	n/a	100.00	224.93	22.74	100.00
500/20/5	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	230.90	2.03	100.00
500/20/10	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	235.16	2.25	100.00
500/50/3	20	0.00	5.00	0.00	95.00	n/a	n/a	100.00	234.08	7.58	100.00
500/50/5	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	240.48	2.09	100.00
500/50/10	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	241.28	2.31	100.00
500/100/3	20	0.00	10.00	0.00	90.00	n/a	n/a	100.00	247.90	12.28	100.00
500/100/5	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	251.03	2.11	100.00
500/100/10	20	0.00	0.00	0.00	100.00	n/a	n/a	100.00	239.37	2.24	100.00

Table 2.7: Comparison of CPO and CPSat for Result Groups of Factory Design Problems

		All Instances				Optimal Only		Non Optimal Only			
		Optimal (% of All Instances)				Time (% of VB)		Cost (% of VB)		Bound (% of VB)	
Group	Nr	Both	CPO	CPSat	None	CPO	CPSat	CPO	CPSat	CPO	CPSat
20	25	76.00	0.00	20.00	4.00	100.00	580.71	100.00	100.00	96.52	100.00

Chapter 3

Taillard Open Shop Problems

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

3.1 Results for CPOptimizer

Table 3.1: Results for Taillard OpenShop (CPO) (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

Table 3.1: Results for Taillard OpenShop (CPO) (60 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

3.2 Results for CPSat

Table 3.2: Results for Taillard OpenShop (CPSat) (60 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai10 10 0.json	10	10	Optimal	0.37	637	0.00	0.00
tai10 10 1.json	10	10	Optimal	0.07	588	0.00	0.00
tai10 10 2.json	10	10	Optimal	0.16	598	0.00	0.00
tai10 10 3.json	10	10	Optimal	0.09	577	0.00	0.00
tai10 10 4.json	10	10	Optimal	0.20	640	0.00	0.00
tai10 10 5.json	10	10	Optimal	0.13	538	0.00	0.00
tai10 10 6.json	10	10	Optimal	0.10	616	0.00	0.00
tai10 10 7.json	10	10	Optimal	0.17	595	0.00	0.00
tai10 10 8.json	10	10	Optimal	0.11	595	0.00	0.00
tai10 10 9.json	10	10	Optimal	0.14	596	0.00	0.00
tai15 15 0.json	15	15	Optimal	0.31	937	0.00	0.00
tai15 15 1.json	15	15	Optimal	0.45	918	0.00	0.00
tai15 15 2.json	15	15	Optimal	0.17	871	0.00	0.00
tai15 15 3.json	15	15	Optimal	0.17	934	0.00	0.00
tai15 15 4.json	15	15	Optimal	0.27	946	0.00	0.00
tai15 15 5.json	15	15	Optimal	0.25	933	0.00	0.00
tai15 15 6.json	15	15	Optimal	0.25	891	0.00	0.00
tai15 15 7.json	15	15	Optimal	0.32	893	0.00	0.00
tai15 15 8.json	15	15	Optimal	1.27	899	0.00	0.00
tai15 15 9.json	15	15	Optimal	0.38	902	0.00	0.00
tai20 20 0.json	20	20	Optimal	1.01	1155	0.00	0.00
tai20 20 1.json	20	20	Optimal	2.44	1241	0.00	0.00
tai20 20 2.json	20	20	Optimal	0.12	1257	0.00	0.00
tai20 20 3.json	20	20	Optimal	0.35	1248	0.00	0.00
tai20 20 4.json	20	20	Optimal	0.40	1256	0.00	0.00
tai20 20 5.json	20	20	Optimal	0.62	1204	0.00	0.00
tai20 20 6.json	20	20	Optimal	0.52	1294	0.00	0.00
tai20 20 7.json	20	20	Optimal	2.13	1169	0.00	0.00
tai20 20 8.json	20	20	Optimal	0.26	1289	0.00	0.00
tai20 20 9.json	20	20	Optimal	0.65	1241	0.00	0.00
tai4 4 0.json	4	4	Optimal	0.02	193	0.00	0.00
tai4 4 1.json	4	4	Optimal	0.03	236	0.00	0.00
tai4 4 2.json	4	4	Optimal	0.01	271	0.00	0.00
tai4 4 3.json	4	4	Optimal	0.01	250	0.00	0.00
tai4 4 4.json	4	4	Optimal	0.03	295	0.00	0.00
tai4 4 5.json	4	4	Optimal	0.01	189	0.00	0.00
tai4 4 6.json	4	4	Optimal	0.01	201	0.00	0.00
tai4 4 7.json	4	4	Optimal	0.01	217	0.00	0.00
tai4 4 8.json	4	4	Optimal	0.01	261	0.00	0.00
tai4 4 9.json	4	4	Optimal	0.01	217	0.00	0.00
tai5 5 0.json	5	5	Optimal	0.06	300	0.00	0.00
tai5 5 1.json	5	5	Optimal	0.04	262	0.00	0.00
tai5 5 2.json	5	5	Optimal	0.12	323	0.00	0.00
tai5 5 3.json	5	5	Optimal	0.07	310	0.00	0.00
tai5 5 4.json	5	5	Optimal	0.16	326	0.00	0.00

Table 3.2: Results for Taillard OpenShop (CPSat) (60 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai5 5 5.json	5	5	Optimal	0.07	312	0.00	0.00
tai5 5 6.json	5	5	Optimal	0.09	303	0.00	0.00
tai5 5 7.json	5	5	Optimal	0.11	300	0.00	0.00
tai5 5 8.json	5	5	Optimal	0.11	353	0.00	0.00
tai5 5 9.json	5	5	Optimal	0.11	326	0.00	0.00
tai7 7 0.json	7	7	Optimal	0.06	435	0.00	0.00
tai7 7 1.json	7	7	Optimal	0.11	443	0.00	0.00
tai7 7 2.json	7	7	Optimal	0.15	468	0.00	0.00
tai7 7 3.json	7	7	Optimal	0.06	463	0.00	0.00
tai7 7 4.json	7	7	Optimal	0.05	416	0.00	0.00
tai7 7 5.json	7	7	Optimal	0.48	451	0.00	0.00
tai7 7 6.json	7	7	Optimal	0.29	422	0.00	0.00
tai7 7 7.json	7	7	Optimal	0.04	424	0.00	0.00
tai7 7 8.json	7	7	Optimal	0.05	458	0.00	0.00
tai7 7 9.json	7	7	Optimal	0.08	398	0.00	0.00

Chapter 4

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.

4.1 Results for CPOptimizer

Table 4.1: Results for Taillard JobShop (CPO) (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

Table 4.1: Results for Taillard JobShop (CPO) (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 4.1: Results for Taillard JobShop (CPO) (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

4.2 Results for CPSat

Table 4.2: Results for Taillard JobShop (CPSat) (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 20 0.json	100	20	Solution	600.17	5616	3654.00	34.94
tai100 20 1.json	100	20	Solution	600.30	5282	3437.00	34.93
tai100 20 2.json	100	20	Optimal	529.40	5568	5568.00	0.00
tai100 20 3.json	100	20	Solution	600.19	5356	3514.00	34.39
tai100 20 4.json	100	20	Solution	600.18	5656	3629.00	35.84
tai100 20 5.json	100	20	Solution	600.17	5411	3554.00	34.32
tai100 20 6.json	100	20	Solution	600.20	5473	3513.00	35.81
tai100 20 7.json	100	20	Solution	600.22	5431	3639.00	33.00
tai100 20 8.json	100	20	Solution	601.09	5409	3610.00	33.26
tai100 20 9.json	100	20	Solution	600.37	5288	3577.00	32.36
tai15 15 0.json	15	15	Optimal	5.32	1231	1231.00	0.00
tai15 15 1.json	15	15	Optimal	44.73	1244	1244.00	0.00
tai15 15 2.json	15	15	Optimal	18.76	1218	1218.00	0.00
tai15 15 3.json	15	15	Optimal	19.12	1175	1175.00	0.00
tai15 15 4.json	15	15	Optimal	216.74	1224	1224.00	0.00
tai15 15 5.json	15	15	Solution	600.10	1238	1202.00	2.91
tai15 15 6.json	15	15	Optimal	246.22	1227	1227.00	0.00
tai15 15 7.json	15	15	Optimal	186.11	1217	1217.00	0.00
tai15 15 8.json	15	15	Optimal	134.40	1274	1274.00	0.00
tai15 15 9.json	15	15	Optimal	20.74	1241	1241.00	0.00
tai20 15 0.json	20	15	Solution	600.11	1368	1309.00	4.31
tai20 15 1.json	20	15	Solution	600.10	1379	1351.00	2.03
tai20 15 2.json	20	15	Solution	600.10	1356	1277.00	5.83

Table 4.2: Results for Taillard JobShop (CPSat) (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai20 15 3.json	20	15	Optimal	9.54	1345	1345.00	0.00
tai20 15 4.json	20	15	Solution	600.13	1355	1301.00	3.99
tai20 15 5.json	20	15	Solution	600.27	1360	1296.00	4.71
tai20 15 6.json	20	15	Optimal	153.89	1462	1462.00	0.00
tai20 15 7.json	20	15	Solution	600.09	1417	1359.00	4.09
tai20 15 8.json	20	15	Solution	600.29	1336	1297.00	2.92
tai20 15 9.json	20	15	Solution	600.10	1355	1315.00	2.95
tai20 20 0.json	20	20	Solution	600.08	1666	1572.00	5.64
tai20 20 1.json	20	20	Solution	600.09	1630	1524.00	6.50
tai20 20 2.json	20	20	Solution	600.21	1565	1491.00	4.73
tai20 20 3.json	20	20	Solution	600.13	1647	1611.00	2.19
tai20 20 4.json	20	20	Solution	600.09	1598	1524.00	4.63
tai20 20 5.json	20	20	Solution	600.15	1663	1557.00	6.37
tai20 20 6.json	20	20	Solution	600.15	1700	1621.00	4.65
tai20 20 7.json	20	20	Solution	600.11	1614	1585.00	1.80
tai20 20 8.json	20	20	Solution	600.10	1640	1529.00	6.77
tai20 20 9.json	20	20	Solution	600.11	1600	1478.00	7.63
tai30 15 0.json	30	15	Solution	600.11	1778	1764.00	0.79
tai30 15 1.json	30	15	Solution	600.20	1851	1774.00	4.16
tai30 15 2.json	30	15	Solution	600.15	1842	1783.00	3.20
tai30 15 3.json	30	15	Solution	600.11	1866	1828.00	2.04
tai30 15 4.json	30	15	Optimal	9.97	2007	2007.00	0.00
tai30 15 5.json	30	15	Solution	600.20	1828	1819.00	0.49
tai30 15 6.json	30	15	Solution	600.12	1815	1771.00	2.42
tai30 15 7.json	30	15	Solution	600.11	1704	1673.00	1.82
tai30 15 8.json	30	15	Optimal	370.42	1795	1795.00	0.00
tai30 15 9.json	30	15	Solution	600.09	1737	1642.00	5.47
tai30 20 0.json	30	20	Solution	600.13	2127	1889.00	11.19
tai30 20 1.json	30	20	Solution	600.13	2019	1873.00	7.23
tai30 20 2.json	30	20	Solution	600.12	1926	1809.00	6.07
tai30 20 3.json	30	20	Solution	600.10	2051	1936.00	5.61
tai30 20 4.json	30	20	Solution	600.12	2100	1997.00	4.90
tai30 20 5.json	30	20	Solution	600.10	2053	1943.00	5.36
tai30 20 6.json	30	20	Solution	600.11	1979	1797.00	9.20
tai30 20 7.json	30	20	Solution	600.12	2001	1912.00	4.45
tai30 20 8.json	30	20	Solution	600.13	2050	1926.00	6.05
tai30 20 9.json	30	20	Solution	600.11	1991	1819.00	8.64
tai50 15 0.json	50	15	Optimal	186.33	2760	2760.00	0.00
tai50 15 1.json	50	15	Optimal	155.63	2756	2756.00	0.00
tai50 15 2.json	50	15	Optimal	68.58	2717	2717.00	0.00
tai50 15 3.json	50	15	Optimal	26.60	2839	2839.00	0.00
tai50 15 4.json	50	15	Optimal	362.73	2679	2679.00	0.00
tai50 15 5.json	50	15	Optimal	249.56	2781	2781.00	0.00
tai50 15 6.json	50	15	Optimal	120.38	2943	2943.00	0.00
tai50 15 7.json	50	15	Optimal	216.50	2885	2885.00	0.00

Table 4.2: Results for Taillard JobShop (CPSat) (80 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai50 15 8.json	50	15	Optimal	435.42	2655	2655.00	0.00
tai50 15 9.json	50	15	Optimal	217.29	2723	2723.00	0.00
tai50 20 0.json	50	20	Solution	600.15	2881	2868.00	0.45
tai50 20 1.json	50	20	Solution	600.22	2981	2869.00	3.76
tai50 20 2.json	50	20	Solution	600.31	2797	2755.00	1.50
tai50 20 3.json	50	20	Solution	600.19	2738	2702.00	1.31
tai50 20 4.json	50	20	Solution	600.18	2805	2725.00	2.85
tai50 20 5.json	50	20	Solution	600.24	2895	2845.00	1.73
tai50 20 6.json	50	20	Solution	600.16	2872	2825.00	1.64
tai50 20 7.json	50	20	Solution	600.19	2829	2784.00	1.59
tai50 20 8.json	50	20	Optimal	302.62	3071	3071.00	0.00
tai50 20 9.json	50	20	Solution	600.25	3046	2995.00	1.67

4.3 Sample Results on Mac (CPOptimizer)

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 4.3: 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 5

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.

5.1 Results for CPOptimizer

Table 5.1: Results for Taillard Flowshop (CPO) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 10 0.json	100	10	Solution	600.16	5910	5759.00	2.55
tai100 10 1.json	100	10	Solution	600.06	5403	5345.00	1.07
tai100 10 2.json	100	10	Solution	600.04	5767	5646.00	2.10
tai100 10 3.json	100	10	Solution	600.05	5943	5737.00	3.47
tai100 10 4.json	100	10	Solution	600.02	5613	5431.00	3.24
tai100 10 5.json	100	10	Solution	600.05	5440	5274.00	3.05
tai100 10 6.json	100	10	Solution	600.05	5691	5553.00	2.42
tai100 10 7.json	100	10	Solution	600.06	5728	5575.00	2.67
tai100 10 8.json	100	10	Solution	600.03	6003	5838.00	2.75
tai100 10 9.json	100	10	Solution	600.04	5983	5835.00	2.47
tai100 20 0.json	100	20	Solution	600.07	6697	5914.00	11.69
tai100 20 1.json	100	20	Solution	600.04	6585	6115.00	7.14
tai100 20 2.json	100	20	Solution	600.08	6700	6139.00	8.37
tai100 20 3.json	100	20	Solution	600.06	6740	6117.00	9.24
tai100 20 4.json	100	20	Solution	600.06	6816	6148.00	9.80
tai100 20 5.json	100	20	Solution	600.06	6884	6192.00	10.05
tai100 20 6.json	100	20	Solution	600.07	6874	6045.00	12.06
tai100 20 7.json	100	20	Solution	600.06	7173	6113.00	14.78
tai100 20 8.json	100	20	Solution	600.06	6971	6014.00	13.73
tai100 20 9.json	100	20	Solution	600.04	6914	6359.00	8.03

Table 5.1: Results for Taillard Flowshop (CPO) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 5 0.json	100	5	Optimal	7.45	5493	5493.00	0.00
tai100 5 1.json	100	5	Optimal	285.63	5257	5257.00	0.00
tai100 5 2.json	100	5	Solution	600.11	5175	5169.00	0.12
tai100 5 3.json	100	5	Optimal	597.59	4993	4993.00	0.00
tai100 5 4.json	100	5	Optimal	494.76	5247	5247.00	0.00
tai100 5 5.json	100	5	Optimal	585.05	5135	5135.00	0.00
tai100 5 6.json	100	5	Optimal	193.99	5232	5232.00	0.00
tai100 5 7.json	100	5	Solution	600.13	5106	5083.00	0.45
tai100 5 8.json	100	5	Solution	600.11	5471	5438.00	0.60
tai100 5 9.json	100	5	Optimal	361.61	5318	5318.00	0.00
tai200 10 0.json	200	10	Solution	600.06	11119	10842.00	2.49
tai200 10 1.json	200	10	Solution	600.09	10958	10429.00	4.83
tai200 10 2.json	200	10	Solution	600.06	11383	10915.00	4.11
tai200 10 3.json	200	10	Solution	600.05	11102	10826.00	2.49
tai200 10 4.json	200	10	Solution	600.08	10950	10474.00	4.35
tai200 10 5.json	200	10	Solution	600.07	10912	10311.00	5.51
tai200 10 6.json	200	10	Solution	600.05	11372	10825.00	4.81
tai200 10 7.json	200	10	Solution	600.10	11090	10709.00	3.44
tai200 10 8.json	200	10	Solution	600.05	10872	10419.00	4.17
tai200 10 9.json	200	10	Solution	600.06	11147	10664.00	4.33
tai200 20 0.json	200	20	Solution	600.15	12486	11010.00	11.82
tai200 20 1.json	200	20	Solution	600.09	12886	10976.00	14.82
tai200 20 2.json	200	20	Solution	600.08	12539	11168.00	10.93
tai200 20 3.json	200	20	Solution	600.12	12739	11131.00	12.62
tai200 20 4.json	200	20	Solution	600.10	12477	11160.00	10.56
tai200 20 5.json	200	20	Solution	600.10	12683	11114.00	12.37
tai200 20 6.json	200	20	Solution	600.09	12888	11249.00	12.72
tai200 20 7.json	200	20	Solution	600.09	12461	11149.00	10.53
tai200 20 8.json	200	20	Solution	600.13	12579	11013.00	12.45
tai200 20 9.json	200	20	Solution	600.09	12821	11167.00	12.90
tai20 10 0.json	20	10	Solution	600.03	1559	1494.00	4.17
tai20 10 1.json	20	10	Solution	600.01	1675	1553.00	7.28
tai20 10 2.json	20	10	Solution	600.01	1485	1425.00	4.04
tai20 10 3.json	20	10	Optimal	141.71	1356	1356.00	0.00
tai20 10 4.json	20	10	Solution	600.03	1403	1353.00	3.56
tai20 10 5.json	20	10	Solution	600.02	1367	1340.00	1.98
tai20 10 6.json	20	10	Solution	600.02	1450	1388.00	4.28
tai20 10 7.json	20	10	Solution	600.02	1531	1415.00	7.58
tai20 10 8.json	20	10	Optimal	56.64	1586	1586.00	0.00
tai20 10 9.json	20	10	Solution	600.02	1574	1504.00	4.45
tai20 20 0.json	20	20	Solution	600.03	2294	1972.00	14.04
tai20 20 1.json	20	20	Solution	600.04	2083	1773.00	14.88
tai20 20 2.json	20	20	Solution	600.04	2280	1970.00	13.60
tai20 20 3.json	20	20	Solution	600.04	2220	1900.00	14.41
tai20 20 4.json	20	20	Solution	600.04	2314	1992.00	13.92

Table 5.1: Results for Taillard Flowshop (CPO) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai20 20 5.json	20	20	Solution	600.04	2185	1893.00	13.36
tai20 20 6.json	20	20	Solution	600.05	2289	1941.00	15.20
tai20 20 7.json	20	20	Solution	600.13	2196	1926.00	12.30
tai20 20 8.json	20	20	Solution	600.03	2230	1896.00	14.98
tai20 20 9.json	20	20	Solution	600.04	2153	1945.00	9.66
tai20 5 0.json	20	5	Optimal	2.33	1278	1278.00	0.00
tai20 5 1.json	20	5	Optimal	2.11	1358	1358.00	0.00
tai20 5 2.json	20	5	Optimal	1.47	1073	1073.00	0.00
tai20 5 3.json	20	5	Optimal	2.85	1292	1292.00	0.00
tai20 5 4.json	20	5	Optimal	6.16	1231	1231.00	0.00
tai20 5 5.json	20	5	Optimal	1.38	1193	1193.00	0.00
tai20 5 6.json	20	5	Optimal	1.40	1234	1234.00	0.00
tai20 5 7.json	20	5	Optimal	1.87	1199	1199.00	0.00
tai20 5 8.json	20	5	Optimal	1.03	1210	1210.00	0.00
tai20 5 9.json	20	5	Optimal	1.25	1103	1103.00	0.00
tai500 20 0.json	500	20	Solution	600.24	28683	25931.00	9.59
tai500 20 1.json	500	20	Solution	600.24	29001	26390.00	9.00
tai500 20 2.json	500	20	Solution	600.24	28688	26330.00	8.22
tai500 20 3.json	500	20	Solution	600.25	28883	26456.00	8.40
tai500 20 4.json	500	20	Solution	600.24	28869	26205.00	9.23
tai500 20 5.json	500	20	Solution	600.21	29025	26436.00	8.92
tai500 20 6.json	500	20	Solution	600.34	28721	26329.00	8.33
tai500 20 7.json	500	20	Solution	600.23	28926	26451.00	8.56
tai500 20 8.json	500	20	Solution	600.25	28115	25929.00	7.78
tai500 20 9.json	500	20	Solution	600.22	28693	26355.00	8.15
tai50 10 0.json	50	10	Solution	600.06	3070	2966.00	3.39
tai50 10 1.json	50	10	Solution	600.06	2928	2828.00	3.42
tai50 10 2.json	50	10	Solution	600.08	2948	2828.00	4.07
tai50 10 3.json	50	10	Solution	600.06	3123	3026.00	3.11
tai50 10 4.json	50	10	Solution	600.07	3043	2919.00	4.07
tai50 10 5.json	50	10	Solution	600.05	3062	2963.00	3.23
tai50 10 6.json	50	10	Solution	600.06	3136	3063.00	2.33
tai50 10 7.json	50	10	Solution	600.06	3097	3000.00	3.13
tai50 10 8.json	50	10	Solution	600.07	2936	2829.00	3.64
tai50 10 9.json	50	10	Solution	600.08	3158	3046.00	3.55
tai50 20 0.json	50	20	Solution	600.16	4118	3567.00	13.38
tai50 20 1.json	50	20	Solution	600.17	3979	3533.00	11.21
tai50 20 2.json	50	20	Solution	600.18	3830	3412.00	10.91
tai50 20 3.json	50	20	Solution	600.16	3920	3382.00	13.72
tai50 20 4.json	50	20	Solution	600.18	3842	3379.00	12.05
tai50 20 5.json	50	20	Solution	600.18	3905	3499.00	10.40
tai50 20 6.json	50	20	Solution	600.20	3889	3464.00	10.93
tai50 20 7.json	50	20	Solution	600.16	3907	3421.00	12.44
tai50 20 8.json	50	20	Solution	600.16	3982	3483.00	12.53
tai50 20 9.json	50	20	Solution	600.18	3996	3493.00	12.59

Table 5.1: Results for Taillard Flowshop (CPO) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai50 5 0.json	50	5	Optimal	24.03	2724	2724.00	0.00
tai50 5 1.json	50	5	Optimal	46.55	2834	2834.00	0.00
tai50 5 2.json	50	5	Optimal	28.75	2612	2612.00	0.00
tai50 5 3.json	50	5	Optimal	21.61	2751	2751.00	0.00
tai50 5 4.json	50	5	Optimal	10.51	2853	2853.00	0.00
tai50 5 5.json	50	5	Optimal	22.57	2825	2825.00	0.00
tai50 5 6.json	50	5	Optimal	56.11	2716	2716.00	0.00
tai50 5 7.json	50	5	Optimal	31.08	2683	2683.00	0.00
tai50 5 8.json	50	5	Optimal	64.19	2545	2545.00	0.00
tai50 5 9.json	50	5	Optimal	1.70	2776	2776.00	0.00

5.2 Results for CPSat

Table 5.2: Results for Taillard Flowshop (CPSat) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 10 0.json	100	10	Solution	600.16	6457	5759.00	10.81
tai100 10 1.json	100	10	Solution	600.14	5938	5345.00	9.99
tai100 10 2.json	100	10	Solution	600.17	6110	5654.00	7.46
tai100 10 3.json	100	10	Solution	600.13	6401	5745.00	10.25
tai100 10 4.json	100	10	Solution	600.27	6049	5437.00	10.12
tai100 10 5.json	100	10	Solution	600.17	5732	5274.00	7.99
tai100 10 6.json	100	10	Solution	600.13	6099	5556.00	8.90
tai100 10 7.json	100	10	Solution	600.16	6201	5586.00	9.92
tai100 10 8.json	100	10	Solution	600.15	6381	5844.00	8.42
tai100 10 9.json	100	10	Solution	600.16	6202	5845.00	5.76
tai100 20 0.json	100	20	Solution	600.17	7409	5939.00	19.84
tai100 20 1.json	100	20	Solution	600.18	7122	6122.00	14.04
tai100 20 2.json	100	20	Solution	600.23	7422	6163.00	16.96
tai100 20 3.json	100	20	Solution	600.16	7033	6117.00	13.02
tai100 20 4.json	100	20	Solution	600.27	7373	6162.00	16.42
tai100 20 5.json	100	20	Solution	601.25	7664	6196.00	19.15
tai100 20 6.json	100	20	Solution	601.48	7247	6060.00	16.38
tai100 20 7.json	100	20	Solution	600.23	7689	6139.00	20.16
tai100 20 8.json	100	20	Solution	601.46	7424	6045.00	18.57
tai100 20 9.json	100	20	Solution	600.18	7395	6359.00	14.01
tai100 5 0.json	100	5	Solution	600.20	5495	5493.00	0.04
tai100 5 1.json	100	5	Solution	600.13	5285	5257.00	0.53
tai100 5 2.json	100	5	Solution	600.17	5221	5173.00	0.92
tai100 5 3.json	100	5	Solution	600.22	5022	4993.00	0.58
tai100 5 4.json	100	5	Solution	600.16	5261	5247.00	0.27

Table 5.2: Results for Taillard Flowshop (CPSat) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai100 5 5.json	100	5	Solution	600.23	5145	5135.00	0.19
tai100 5 6.json	100	5	Solution	600.23	5294	5228.00	1.25
tai100 5 7.json	100	5	Solution	600.17	5130	5083.00	0.92
tai100 5 8.json	100	5	Solution	600.24	5476	5442.00	0.62
tai100 5 9.json	100	5	Solution	600.31	5356	5310.00	0.86
tai200 10 0.json	200	10	Solution	600.28	12038	10842.00	9.94
tai200 10 1.json	200	10	Solution	600.21	12337	10430.00	15.46
tai200 10 2.json	200	10	Solution	600.27	12103	10915.00	9.82
tai200 10 3.json	200	10	Solution	600.22	11962	10846.00	9.33
tai200 10 4.json	200	10	Solution	600.22	12038	10472.00	13.01
tai200 10 5.json	200	10	Solution	600.22	11692	10311.00	11.81
tai200 10 6.json	200	10	Solution	600.27	12217	10832.00	11.34
tai200 10 7.json	200	10	Solution	601.23	12155	10710.00	11.89
tai200 10 8.json	200	10	Solution	600.26	11834	10419.00	11.96
tai200 10 9.json	200	10	Solution	600.25	11758	10666.00	9.29
tai200 20 0.json	200	20	Solution	600.37	13306	11005.00	17.29
tai200 20 1.json	200	20	Solution	600.94	13314	10976.00	17.56
tai200 20 2.json	200	20	Solution	600.32	13299	11169.00	16.02
tai200 20 3.json	200	20	Solution	600.33	13544	11132.00	17.81
tai200 20 4.json	200	20	Solution	600.33	13291	11162.00	16.02
tai200 20 5.json	200	20	Solution	600.35	13557	11117.00	18.00
tai200 20 6.json	200	20	Solution	601.68	13575	11251.00	17.12
tai200 20 7.json	200	20	Solution	600.34	13208	11157.00	15.53
tai200 20 8.json	200	20	Solution	601.09	13322	10999.00	17.44
tai200 20 9.json	200	20	Solution	601.14	13557	11162.00	17.67
tai20 10 0.json	20	10	Solution	600.17	1574	1548.00	1.65
tai20 10 1.json	20	10	Solution	600.33	1674	1587.00	5.20
tai20 10 2.json	20	10	Solution	600.12	1479	1438.00	2.77
tai20 10 3.json	20	10	Solution	600.13	1376	1356.00	1.45
tai20 10 4.json	20	10	Solution	600.14	1424	1361.00	4.42
tai20 10 5.json	20	10	Solution	600.16	1383	1356.00	1.95
tai20 10 6.json	20	10	Solution	600.13	1446	1398.00	3.32
tai20 10 7.json	20	10	Solution	600.14	1531	1448.00	5.42
tai20 10 8.json	20	10	Optimal	235.18	1586	1586.00	0.00
tai20 10 9.json	20	10	Solution	600.15	1559	1529.00	1.92
tai20 20 0.json	20	20	Solution	600.12	2332	2048.00	12.18
tai20 20 1.json	20	20	Solution	600.12	2092	1852.00	11.47
tai20 20 2.json	20	20	Solution	600.12	2394	1999.00	16.50
tai20 20 3.json	20	20	Solution	600.14	2350	1961.00	16.55
tai20 20 4.json	20	20	Solution	600.12	2289	2065.00	9.79
tai20 20 5.json	20	20	Solution	600.13	2213	1980.00	10.53
tai20 20 6.json	20	20	Solution	600.10	2291	2007.00	12.40
tai20 20 7.json	20	20	Solution	600.12	2178	1986.00	8.82
tai20 20 8.json	20	20	Solution	600.29	2312	1968.00	14.88
tai20 20 9.json	20	20	Solution	600.29	2210	1971.00	10.81

Table 5.2: Results for Taillard Flowshop (CPSat) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai20 5 0.json	20	5	Optimal	5.54	1278	1278.00	0.00
tai20 5 1.json	20	5	Optimal	1.93	1358	1358.00	0.00
tai20 5 2.json	20	5	Optimal	3.14	1073	1073.00	0.00
tai20 5 3.json	20	5	Optimal	6.82	1292	1292.00	0.00
tai20 5 4.json	20	5	Optimal	7.32	1231	1231.00	0.00
tai20 5 5.json	20	5	Optimal	5.25	1193	1193.00	0.00
tai20 5 6.json	20	5	Optimal	4.38	1234	1234.00	0.00
tai20 5 7.json	20	5	Optimal	4.85	1199	1199.00	0.00
tai20 5 8.json	20	5	Optimal	0.92	1210	1210.00	0.00
tai20 5 9.json	20	5	Optimal	3.82	1103	1103.00	0.00
tai500 20 0.json	500	20	Solution	607.49	30253	13560.00	55.18
tai500 20 1.json	500	20	Solution	601.41	30898	13905.00	55.00
tai500 20 2.json	500	20	Solution	608.27	30581	13845.00	54.73
tai500 20 3.json	500	20	Solution	604.80	30583	13868.00	54.65
tai500 20 4.json	500	20	Solution	608.12	30483	13744.00	54.91
tai500 20 5.json	500	20	Solution	601.34	30860	13724.00	55.53
tai500 20 6.json	500	20	Solution	601.33	30742	13840.00	54.98
tai500 20 7.json	500	20	Solution	603.96	30740	13927.00	54.69
tai500 20 8.json	500	20	Solution	608.54	30365	13646.00	55.06
tai500 20 9.json	500	20	Solution	601.47	30675	13785.00	55.06
tai50 10 0.json	50	10	Solution	600.19	3209	2976.00	7.26
tai50 10 1.json	50	10	Solution	600.19	3017	2829.00	6.23
tai50 10 2.json	50	10	Solution	600.16	3016	2830.00	6.17
tai50 10 3.json	50	10	Solution	600.16	3235	3059.00	5.44
tai50 10 4.json	50	10	Solution	600.16	3168	2933.00	7.42
tai50 10 5.json	50	10	Solution	600.15	3156	2985.00	5.42
tai50 10 6.json	50	10	Solution	600.15	3256	3093.00	5.01
tai50 10 7.json	50	10	Solution	600.15	3203	3003.00	6.24
tai50 10 8.json	50	10	Solution	600.32	3006	2864.00	4.72
tai50 10 9.json	50	10	Solution	600.22	3245	3046.00	6.13
tai50 20 0.json	50	20	Solution	600.16	4187	3593.00	14.19
tai50 20 1.json	50	20	Solution	600.18	4104	3554.00	13.40
tai50 20 2.json	50	20	Solution	600.18	4017	3432.00	14.56
tai50 20 3.json	50	20	Solution	600.18	4294	3420.00	20.35
tai50 20 4.json	50	20	Solution	600.16	4164	3412.00	18.06
tai50 20 5.json	50	20	Solution	600.14	4083	3516.00	13.89
tai50 20 6.json	50	20	Solution	600.24	4115	3499.00	14.97
tai50 20 7.json	50	20	Solution	600.19	4121	3454.00	16.19
tai50 20 8.json	50	20	Solution	600.19	4102	3490.00	14.92
tai50 20 9.json	50	20	Solution	600.19	4222	3519.00	16.65
tai50 5 0.json	50	5	Optimal	50.65	2724	2724.00	0.00
tai50 5 1.json	50	5	Optimal	40.78	2834	2834.00	0.00
tai50 5 2.json	50	5	Optimal	90.65	2612	2612.00	0.00
tai50 5 3.json	50	5	Optimal	61.30	2751	2751.00	0.00
tai50 5 4.json	50	5	Optimal	27.88	2853	2853.00	0.00

Table 5.2: Results for Taillard Flowshop (CPSat) (120 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
tai50 5 5.json	50	5	Optimal	36.25	2825	2825.00	0.00
tai50 5 6.json	50	5	Optimal	399.71	2716	2716.00	0.00
tai50 5 7.json	50	5	Optimal	52.87	2683	2683.00	0.00
tai50 5 8.json	50	5	Optimal	161.70	2545	2545.00	0.00
tai50 5 9.json	50	5	Optimal	34.36	2776	2776.00	0.00

5.3 Permutation Flowshop Results for CPOptimizer

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 5.3: Results for Taillard Permutation Flowshop (CPO) (120 Instances)

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 5.3: Results for Taillard Permutation Flowshop (CPO) (120 Instances)

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 5.3: Results for Taillard Permutation Flowshop (CPO) (120 Instances)

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 5.3: Results for Taillard Permutation Flowshop (CPO) (120 Instances)

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 6

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.

6.1 Results for CPOptimizer

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 1.alb	1	0	Solution	30.10	136	135.00	0.74
instance n=1000 10.alb	1	0	Solution	30.08	141	140.00	0.71
instance n=1000 100.alb	1	0	Solution	30.10	139	137.00	1.44
instance n=1000 101.alb	1	0	Solution	30.18	558	505.00	9.50
instance n=1000 102.alb	1	0	Solution	30.18	557	503.00	9.69
instance n=1000 103.alb	1	0	Solution	30.19	562	503.00	10.50
instance n=1000 104.alb	1	0	Solution	30.21	555	504.00	9.19
instance n=1000 105.alb	1	0	Solution	30.16	549	499.00	9.11
instance n=1000 106.alb	1	0	Solution	30.18	556	499.00	10.25
instance n=1000 107.alb	1	0	Solution	30.17	540	496.00	8.15
instance n=1000 108.alb	1	0	Solution	30.18	546	498.00	8.79
instance n=1000 109.alb	1	0	Solution	30.19	550	500.00	9.09
instance n=1000 11.alb	1	0	Solution	30.05	135	134.00	0.74
instance n=1000 110.alb	1	0	Solution	30.23	557	501.00	10.05
instance n=1000 111.alb	1	0	Solution	30.19	550	500.00	9.09
instance n=1000 112.alb	1	0	Solution	30.19	550	499.00	9.27
instance n=1000 113.alb	1	0	Solution	30.22	543	495.00	8.84

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 114.alb	1	0	Solution	30.19	552	502.00	9.06
instance n=1000 115.alb	1	0	Solution	30.20	542	498.00	8.12
instance n=1000 116.alb	1	0	Solution	30.16	546	496.00	9.16
instance n=1000 117.alb	1	0	Solution	30.20	552	500.00	9.42
instance n=1000 118.alb	1	0	Solution	30.19	566	509.00	10.07
instance n=1000 119.alb	1	0	Solution	30.20	532	496.00	6.77
instance n=1000 12.alb	1	0	Solution	30.05	135	134.00	0.74
instance n=1000 120.alb	1	0	Solution	30.16	549	502.00	8.56
instance n=1000 121.alb	1	0	Solution	30.20	542	496.00	8.49
instance n=1000 122.alb	1	0	Solution	30.17	535	493.00	7.85
instance n=1000 123.alb	1	0	Solution	30.16	557	504.00	9.52
instance n=1000 124.alb	1	0	Solution	30.25	544	498.00	8.46
instance n=1000 125.alb	1	0	Solution	30.17	546	499.00	8.61
instance n=1000 126.alb	1	0	Solution	30.09	232	228.00	1.72
instance n=1000 127.alb	1	0	Solution	30.10	224	221.00	1.34
instance n=1000 128.alb	1	0	Solution	30.10	225	222.00	1.33
instance n=1000 129.alb	1	0	Solution	30.16	226	223.00	1.33
instance n=1000 13.alb	1	0	Solution	30.12	132	131.00	0.76
instance n=1000 130.alb	1	0	Solution	30.10	225	221.00	1.78
instance n=1000 131.alb	1	0	Solution	30.08	223	220.00	1.35
instance n=1000 132.alb	1	0	Solution	30.10	218	214.00	1.83
instance n=1000 133.alb	1	0	Solution	30.10	230	226.00	1.74
instance n=1000 134.alb	1	0	Solution	30.12	219	215.00	1.83
instance n=1000 135.alb	1	0	Solution	30.14	229	225.00	1.75
instance n=1000 136.alb	1	0	Solution	30.11	233	228.00	2.15
instance n=1000 137.alb	1	0	Solution	30.19	217	213.00	1.84
instance n=1000 138.alb	1	0	Solution	30.10	225	221.00	1.78
instance n=1000 139.alb	1	0	Solution	30.10	228	224.00	1.75
instance n=1000 14.alb	1	0	Solution	30.07	138	136.00	1.45
instance n=1000 140.alb	1	0	Solution	30.09	230	226.00	1.74
instance n=1000 141.alb	1	0	Solution	30.12	219	215.00	1.83
instance n=1000 142.alb	1	0	Solution	30.13	223	220.00	1.35
instance n=1000 143.alb	1	0	Solution	30.10	217	213.00	1.84
instance n=1000 144.alb	1	0	Solution	30.19	221	217.00	1.81
instance n=1000 145.alb	1	0	Solution	30.09	224	220.00	1.79
instance n=1000 146.alb	1	0	Solution	30.06	224	219.00	2.23
instance n=1000 147.alb	1	0	Solution	30.18	234	229.00	2.14
instance n=1000 148.alb	1	0	Solution	30.12	223	219.00	1.79
instance n=1000 149.alb	1	0	Solution	30.11	241	237.00	1.66
instance n=1000 15.alb	1	0	Solution	30.10	137	136.00	0.73
instance n=1000 150.alb	1	0	Solution	30.11	226	222.00	1.77
instance n=1000 151.alb	1	0	Solution	30.19	140	138.00	1.43
instance n=1000 152.alb	1	0	Solution	30.13	138	136.00	1.45
instance n=1000 153.alb	1	0	Solution	30.11	139	137.00	1.44
instance n=1000 154.alb	1	0	Solution	30.07	142	140.00	1.41

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 155.alb	1	0	Solution	30.13	141	139.00	1.42
instance n=1000 156.alb	1	0	Solution	30.12	143	141.00	1.40
instance n=1000 157.alb	1	0	Solution	30.10	142	140.00	1.41
instance n=1000 158.alb	1	0	Solution	30.12	137	136.00	0.73
instance n=1000 159.alb	1	0	Solution	30.13	140	138.00	1.43
instance n=1000 16.alb	1	0	Solution	30.14	138	137.00	0.72
instance n=1000 160.alb	1	0	Solution	30.11	140	138.00	1.43
instance n=1000 161.alb	1	0	Solution	30.11	134	133.00	0.75
instance n=1000 162.alb	1	0	Solution	30.15	137	136.00	0.73
instance n=1000 163.alb	1	0	Solution	30.05	141	139.00	1.42
instance n=1000 164.alb	1	0	Solution	30.08	143	141.00	1.40
instance n=1000 165.alb	1	0	Solution	30.05	137	135.00	1.46
instance n=1000 166.alb	1	0	Solution	30.15	141	139.00	1.42
instance n=1000 167.alb	1	0	Solution	30.20	141	139.00	1.42
instance n=1000 168.alb	1	0	Solution	30.13	140	138.00	1.43
instance n=1000 169.alb	1	0	Solution	30.05	136	134.00	1.47
instance n=1000 17.alb	1	0	Solution	30.08	136	135.00	0.74
instance n=1000 170.alb	1	0	Solution	30.05	136	134.00	1.47
instance n=1000 171.alb	1	0	Solution	30.17	139	137.00	1.44
instance n=1000 172.alb	1	0	Solution	30.11	136	135.00	0.74
instance n=1000 173.alb	1	0	Solution	30.09	137	135.00	1.46
instance n=1000 174.alb	1	0	Solution	30.11	138	136.00	1.45
instance n=1000 175.alb	1	0	Solution	30.11	140	138.00	1.43
instance n=1000 176.alb	1	0	Solution	30.23	559	500.00	10.55
instance n=1000 177.alb	1	0	Solution	30.17	552	499.00	9.60
instance n=1000 178.alb	1	0	Solution	30.22	568	506.00	10.92
instance n=1000 179.alb	1	0	Solution	30.25	565	505.00	10.62
instance n=1000 18.alb	1	0	Solution	30.11	135	134.00	0.74
instance n=1000 180.alb	1	0	Solution	30.22	563	503.00	10.66
instance n=1000 181.alb	1	0	Solution	30.24	567	505.00	10.93
instance n=1000 182.alb	1	0	Solution	30.20	561	502.00	10.52
instance n=1000 183.alb	1	0	Solution	30.18	552	500.00	9.42
instance n=1000 184.alb	1	0	Solution	30.18	562	502.00	10.68
instance n=1000 185.alb	1	0	Solution	30.21	565	503.00	10.97
instance n=1000 186.alb	1	0	Solution	30.23	557	500.00	10.23
instance n=1000 187.alb	1	0	Solution	30.21	569	505.00	11.25
instance n=1000 188.alb	1	0	Solution	30.21	553	498.00	9.95
instance n=1000 189.alb	1	0	Solution	30.22	556	498.00	10.43
instance n=1000 19.alb	1	0	Solution	30.14	138	137.00	0.72
instance n=1000 190.alb	1	0	Solution	30.18	556	501.00	9.89
instance n=1000 191.alb	1	0	Solution	30.18	555	501.00	9.73
instance n=1000 192.alb	1	0	Solution	30.24	559	501.00	10.38
instance n=1000 193.alb	1	0	Solution	30.20	564	503.00	10.82
instance n=1000 194.alb	1	0	Solution	30.25	561	502.00	10.52
instance n=1000 195.alb	1	0	Solution	30.18	567	502.00	11.46

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 196.alb	1	0	Solution	30.21	561	500.00	10.87
instance n=1000 197.alb	1	0	Solution	30.22	550	496.00	9.82
instance n=1000 198.alb	1	0	Solution	30.19	566	503.00	11.13
instance n=1000 199.alb	1	0	Solution	30.24	542	495.00	8.67
instance n=1000 2.alb	1	0	Solution	30.12	138	137.00	0.72
instance n=1000 20.alb	1	0	Solution	30.13	139	138.00	0.72
instance n=1000 200.alb	1	0	Solution	30.26	554	498.00	10.11
instance n=1000 201.alb	1	0	Solution	30.18	233	229.00	1.72
instance n=1000 202.alb	1	0	Solution	30.09	230	225.00	2.17
instance n=1000 203.alb	1	0	Solution	30.15	234	229.00	2.14
instance n=1000 204.alb	1	0	Solution	30.16	233	228.00	2.15
instance n=1000 205.alb	1	0	Solution	30.12	234	229.00	2.14
instance n=1000 206.alb	1	0	Solution	30.08	233	229.00	1.72
instance n=1000 207.alb	1	0	Solution	30.17	235	230.00	2.13
instance n=1000 208.alb	1	0	Solution	30.11	234	229.00	2.14
instance n=1000 209.alb	1	0	Solution	30.19	233	228.00	2.15
instance n=1000 21.alb	1	0	Solution	30.07	139	138.00	0.72
instance n=1000 210.alb	1	0	Solution	30.14	229	224.00	2.18
instance n=1000 211.alb	1	0	Solution	30.08	223	219.00	1.79
instance n=1000 212.alb	1	0	Solution	30.12	221	217.00	1.81
instance n=1000 213.alb	1	0	Solution	30.18	238	233.00	2.10
instance n=1000 214.alb	1	0	Solution	30.09	230	225.00	2.17
instance n=1000 215.alb	1	0	Solution	30.14	227	223.00	1.76
instance n=1000 216.alb	1	0	Solution	30.25	225	221.00	1.78
instance n=1000 217.alb	1	0	Solution	30.12	229	225.00	1.75
instance n=1000 218.alb	1	0	Solution	30.17	223	219.00	1.79
instance n=1000 219.alb	1	0	Solution	30.18	236	232.00	1.69
instance n=1000 22.alb	1	0	Solution	30.09	139	137.00	1.44
instance n=1000 220.alb	1	0	Solution	30.23	229	225.00	1.75
instance n=1000 221.alb	1	0	Solution	30.25	236	231.00	2.12
instance n=1000 222.alb	1	0	Solution	30.10	226	221.00	2.21
instance n=1000 223.alb	1	0	Solution	30.13	226	221.00	2.21
instance n=1000 224.alb	1	0	Solution	30.09	231	226.00	2.16
instance n=1000 225.alb	1	0	Solution	30.12	234	229.00	2.14
instance n=1000 226.alb	1	0	Solution	30.19	138	136.00	1.45
instance n=1000 227.alb	1	0	Solution	30.29	140	138.00	1.43
instance n=1000 228.alb	1	0	Solution	30.07	135	133.00	1.48
instance n=1000 229.alb	1	0	Solution	30.08	136	134.00	1.47
instance n=1000 23.alb	1	0	Solution	30.15	137	136.00	0.73
instance n=1000 230.alb	1	0	Solution	30.22	134	131.00	2.24
instance n=1000 231.alb	1	0	Solution	30.09	141	138.00	2.13
instance n=1000 232.alb	1	0	Solution	30.08	136	133.00	2.21
instance n=1000 233.alb	1	0	Solution	30.15	138	135.00	2.17
instance n=1000 234.alb	1	0	Solution	30.07	139	137.00	1.44
instance n=1000 235.alb	1	0	Solution	30.25	134	133.00	0.75

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 236.alb	1	0	Solution	30.05	138	136.00	1.45
instance n=1000 237.alb	1	0	Solution	30.12	141	138.00	2.13
instance n=1000 238.alb	1	0	Solution	30.32	140	138.00	1.43
instance n=1000 239.alb	1	0	Solution	30.30	137	135.00	1.46
instance n=1000 24.alb	1	0	Solution	30.23	141	140.00	0.71
instance n=1000 240.alb	1	0	Solution	30.15	138	135.00	2.17
instance n=1000 241.alb	1	0	Solution	30.15	140	138.00	1.43
instance n=1000 242.alb	1	0	Solution	30.18	137	135.00	1.46
instance n=1000 243.alb	1	0	Solution	30.13	139	137.00	1.44
instance n=1000 244.alb	1	0	Solution	30.28	139	137.00	1.44
instance n=1000 245.alb	1	0	Solution	30.11	137	135.00	1.46
instance n=1000 246.alb	1	0	Solution	30.19	138	135.00	2.17
instance n=1000 247.alb	1	0	Solution	30.07	141	138.00	2.13
instance n=1000 248.alb	1	0	Solution	30.23	141	138.00	2.13
instance n=1000 249.alb	1	0	Solution	30.16	141	138.00	2.13
instance n=1000 25.alb	1	0	Solution	30.08	137	136.00	0.73
instance n=1000 250.alb	1	0	Solution	30.28	142	140.00	1.41
instance n=1000 251.alb	1	0	Solution	30.20	575	502.00	12.70
instance n=1000 252.alb	1	0	Solution	30.18	574	501.00	12.72
instance n=1000 253.alb	1	0	Solution	30.17	568	502.00	11.62
instance n=1000 254.alb	1	0	Solution	30.20	569	501.00	11.95
instance n=1000 255.alb	1	0	Solution	30.20	561	498.00	11.23
instance n=1000 256.alb	1	0	Solution	30.19	562	495.00	11.92
instance n=1000 257.alb	1	0	Solution	30.21	575	502.00	12.70
instance n=1000 258.alb	1	0	Solution	30.29	565	497.00	12.04
instance n=1000 259.alb	1	0	Solution	30.30	563	496.00	11.90
instance n=1000 26.alb	1	0	Solution	30.28	555	502.00	9.55
instance n=1000 260.alb	1	0	Solution	30.20	562	495.00	11.92
instance n=1000 261.alb	1	0	Solution	30.21	570	501.00	12.11
instance n=1000 262.alb	1	0	Solution	30.19	551	495.00	10.16
instance n=1000 263.alb	1	0	Solution	30.33	567	499.00	11.99
instance n=1000 264.alb	1	0	Solution	30.19	562	499.00	11.21
instance n=1000 265.alb	1	0	Solution	30.36	586	506.00	13.65
instance n=1000 266.alb	1	0	Solution	30.22	566	500.00	11.66
instance n=1000 267.alb	1	0	Solution	30.36	576	506.00	12.15
instance n=1000 268.alb	1	0	Solution	30.21	562	497.00	11.57
instance n=1000 269.alb	1	0	Solution	30.22	561	500.00	10.87
instance n=1000 27.alb	1	0	Solution	30.21	554	502.00	9.39
instance n=1000 270.alb	1	0	Solution	30.21	584	508.00	13.01
instance n=1000 271.alb	1	0	Solution	30.18	557	497.00	10.77
instance n=1000 272.alb	1	0	Solution	30.22	572	502.00	12.24
instance n=1000 273.alb	1	0	Solution	30.38	569	500.00	12.13
instance n=1000 274.alb	1	0	Solution	30.21	565	496.00	12.21
instance n=1000 275.alb	1	0	Solution	30.18	574	504.00	12.20
instance n=1000 276.alb	1	0	Solution	30.12	223	217.00	2.69

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 277.alb	1	0	Solution	30.18	231	225.00	2.60
instance n=1000 278.alb	1	0	Solution	30.10	226	220.00	2.65
instance n=1000 279.alb	1	0	Solution	30.30	220	215.00	2.27
instance n=1000 28.alb	1	0	Solution	30.18	538	497.00	7.62
instance n=1000 280.alb	1	0	Solution	30.17	231	226.00	2.16
instance n=1000 281.alb	1	0	Solution	30.18	225	219.00	2.67
instance n=1000 282.alb	1	0	Solution	30.13	220	214.00	2.73
instance n=1000 283.alb	1	0	Solution	30.12	230	224.00	2.61
instance n=1000 284.alb	1	0	Solution	30.10	222	217.00	2.25
instance n=1000 285.alb	1	0	Solution	30.15	227	221.00	2.64
instance n=1000 286.alb	1	0	Solution	30.12	227	221.00	2.64
instance n=1000 287.alb	1	0	Solution	30.19	230	224.00	2.61
instance n=1000 288.alb	1	0	Solution	30.16	225	219.00	2.67
instance n=1000 289.alb	1	0	Solution	30.09	225	220.00	2.22
instance n=1000 29.alb	1	0	Solution	30.18	545	498.00	8.62
instance n=1000 290.alb	1	0	Solution	30.08	228	222.00	2.63
instance n=1000 291.alb	1	0	Solution	30.15	231	225.00	2.60
instance n=1000 292.alb	1	0	Solution	30.12	232	226.00	2.59
instance n=1000 293.alb	1	0	Solution	30.26	231	225.00	2.60
instance n=1000 294.alb	1	0	Solution	30.10	236	230.00	2.54
instance n=1000 295.alb	1	0	Solution	30.09	233	227.00	2.58
instance n=1000 296.alb	1	0	Solution	30.12	213	208.00	2.35
instance n=1000 297.alb	1	0	Solution	30.10	222	217.00	2.25
instance n=1000 298.alb	1	0	Solution	30.26	220	214.00	2.73
instance n=1000 299.alb	1	0	Solution	30.27	232	226.00	2.59
instance n=1000 3.alb	1	0	Solution	30.24	138	136.00	1.45
instance n=1000 30.alb	1	0	Solution	30.24	559	506.00	9.48
instance n=1000 300.alb	1	0	Solution	30.10	234	228.00	2.56
instance n=1000 301.alb	1	0	Solution	30.13	138	137.00	0.72
instance n=1000 302.alb	1	0	Solution	30.41	140	139.00	0.71
instance n=1000 303.alb	1	0	Solution	30.10	140	138.00	1.43
instance n=1000 304.alb	1	0	Solution	30.08	138	136.00	1.45
instance n=1000 305.alb	1	0	Solution	30.06	141	140.00	0.71
instance n=1000 306.alb	1	0	Solution	30.20	136	135.00	0.74
instance n=1000 307.alb	1	0	Solution	30.29	137	136.00	0.73
instance n=1000 308.alb	1	0	Solution	30.11	138	137.00	0.72
instance n=1000 309.alb	1	0	Solution	30.23	136	135.00	0.74
instance n=1000 31.alb	1	0	Solution	30.27	558	506.00	9.32
instance n=1000 310.alb	1	0	Solution	30.10	143	141.00	1.40
instance n=1000 311.alb	1	0	Solution	30.21	141	139.00	1.42
instance n=1000 312.alb	1	0	Solution	30.12	136	135.00	0.74
instance n=1000 313.alb	1	0	Solution	30.09	139	138.00	0.72
instance n=1000 314.alb	1	0	Solution	30.27	143	142.00	0.70
instance n=1000 315.alb	1	0	Solution	30.20	138	136.00	1.45
instance n=1000 316.alb	1	0	Solution	30.34	139	137.00	1.44

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 317.alb	1	0	Solution	30.09	137	136.00	0.73
instance n=1000 318.alb	1	0	Solution	30.20	139	138.00	0.72
instance n=1000 319.alb	1	0	Solution	30.18	142	140.00	1.41
instance n=1000 32.alb	1	0	Solution	30.38	543	502.00	7.55
instance n=1000 320.alb	1	0	Solution	30.05	142	141.00	0.70
instance n=1000 321.alb	1	0	Solution	30.19	141	140.00	0.71
instance n=1000 322.alb	1	0	Solution	30.14	140	139.00	0.71
instance n=1000 323.alb	1	0	Solution	30.14	140	138.00	1.43
instance n=1000 324.alb	1	0	Solution	30.06	141	140.00	0.71
instance n=1000 325.alb	1	0	Solution	30.39	140	138.00	1.43
instance n=1000 326.alb	1	0	Solution	30.19	542	496.00	8.49
instance n=1000 327.alb	1	0	Solution	30.24	554	503.00	9.21
instance n=1000 328.alb	1	0	Solution	30.25	546	500.00	8.42
instance n=1000 329.alb	1	0	Solution	30.25	555	502.00	9.55
instance n=1000 33.alb	1	0	Solution	30.31	548	501.00	8.58
instance n=1000 330.alb	1	0	Solution	30.25	538	498.00	7.43
instance n=1000 331.alb	1	0	Solution	30.21	547	498.00	8.96
instance n=1000 332.alb	1	0	Solution	30.20	535	495.00	7.48
instance n=1000 333.alb	1	0	Solution	30.21	554	499.00	9.93
instance n=1000 334.alb	1	0	Solution	30.27	540	498.00	7.78
instance n=1000 335.alb	1	0	Solution	30.24	544	496.00	8.82
instance n=1000 336.alb	1	0	Solution	30.25	534	497.00	6.93
instance n=1000 337.alb	1	0	Solution	30.20	551	501.00	9.07
instance n=1000 338.alb	1	0	Solution	30.20	553	502.00	9.22
instance n=1000 339.alb	1	0	Solution	30.21	556	500.00	10.07
instance n=1000 34.alb	1	0	Solution	30.22	563	507.00	9.95
instance n=1000 340.alb	1	0	Solution	30.27	566	505.00	10.78
instance n=1000 341.alb	1	0	Solution	30.33	552	503.00	8.88
instance n=1000 342.alb	1	0	Solution	30.21	549	500.00	8.93
instance n=1000 343.alb	1	0	Solution	30.23	556	500.00	10.07
instance n=1000 344.alb	1	0	Solution	30.20	546	500.00	8.42
instance n=1000 345.alb	1	0	Solution	30.29	554	502.00	9.39
instance n=1000 346.alb	1	0	Solution	30.21	552	501.00	9.24
instance n=1000 347.alb	1	0	Solution	30.19	547	498.00	8.96
instance n=1000 348.alb	1	0	Solution	30.44	566	506.00	10.60
instance n=1000 349.alb	1	0	Solution	30.21	559	503.00	10.02
instance n=1000 35.alb	1	0	Solution	30.22	544	501.00	7.90
instance n=1000 350.alb	1	0	Solution	30.20	534	496.00	7.12
instance n=1000 351.alb	1	0	Solution	30.27	231	227.00	1.73
instance n=1000 352.alb	1	0	Solution	30.32	231	227.00	1.73
instance n=1000 353.alb	1	0	Solution	30.30	221	217.00	1.81
instance n=1000 354.alb	1	0	Solution	30.35	226	222.00	1.77
instance n=1000 355.alb	1	0	Solution	30.20	224	220.00	1.79
instance n=1000 356.alb	1	0	Solution	30.33	230	226.00	1.74
instance n=1000 357.alb	1	0	Solution	30.43	217	213.00	1.84

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 358.alb	1	0	Solution	30.24	223	219.00	1.79
instance n=1000 359.alb	1	0	Solution	30.14	226	222.00	1.77
instance n=1000 36.alb	1	0	Solution	30.24	538	497.00	7.62
instance n=1000 360.alb	1	0	Solution	30.10	233	229.00	1.72
instance n=1000 361.alb	1	0	Solution	30.20	219	215.00	1.83
instance n=1000 362.alb	1	0	Solution	30.14	226	223.00	1.33
instance n=1000 363.alb	1	0	Solution	30.14	219	215.00	1.83
instance n=1000 364.alb	1	0	Solution	30.16	225	221.00	1.78
instance n=1000 365.alb	1	0	Solution	30.34	231	227.00	1.73
instance n=1000 366.alb	1	0	Solution	30.29	232	228.00	1.72
instance n=1000 367.alb	1	0	Solution	30.14	231	227.00	1.73
instance n=1000 368.alb	1	0	Solution	30.18	230	226.00	1.74
instance n=1000 369.alb	1	0	Solution	30.10	224	220.00	1.79
instance n=1000 37.alb	1	0	Solution	30.24	562	506.00	9.96
instance n=1000 370.alb	1	0	Solution	30.10	227	223.00	1.76
instance n=1000 371.alb	1	0	Solution	30.29	223	220.00	1.35
instance n=1000 372.alb	1	0	Solution	30.33	234	230.00	1.71
instance n=1000 373.alb	1	0	Solution	30.62	223	219.00	1.79
instance n=1000 374.alb	1	0	Solution	30.11	222	219.00	1.35
instance n=1000 375.alb	1	0	Solution	30.15	231	227.00	1.73
instance n=1000 376.alb	1	0	Solution	30.23	134	132.00	1.49
instance n=1000 377.alb	1	0	Solution	30.20	139	137.00	1.44
instance n=1000 378.alb	1	0	Solution	30.27	136	134.00	1.47
instance n=1000 379.alb	1	0	Solution	30.26	139	137.00	1.44
instance n=1000 38.alb	1	0	Solution	30.21	557	504.00	9.52
instance n=1000 380.alb	1	0	Solution	30.36	136	134.00	1.47
instance n=1000 381.alb	1	0	Solution	30.11	140	138.00	1.43
instance n=1000 382.alb	1	0	Solution	30.27	133	131.00	1.50
instance n=1000 383.alb	1	0	Solution	30.16	141	138.00	2.13
instance n=1000 384.alb	1	0	Solution	30.09	141	139.00	1.42
instance n=1000 385.alb	1	0	Solution	30.29	137	135.00	1.46
instance n=1000 386.alb	1	0	Solution	30.36	141	139.00	1.42
instance n=1000 387.alb	1	0	Solution	30.08	139	137.00	1.44
instance n=1000 388.alb	1	0	Solution	30.14	139	137.00	1.44
instance n=1000 389.alb	1	0	Solution	30.30	138	136.00	1.45
instance n=1000 39.alb	1	0	Solution	30.27	561	507.00	9.63
instance n=1000 390.alb	1	0	Solution	30.28	138	136.00	1.45
instance n=1000 391.alb	1	0	Solution	30.06	137	135.00	1.46
instance n=1000 392.alb	1	0	Solution	30.18	137	136.00	0.73
instance n=1000 393.alb	1	0	Solution	30.30	138	136.00	1.45
instance n=1000 394.alb	1	0	Solution	30.23	140	138.00	1.43
instance n=1000 395.alb	1	0	Solution	30.31	141	139.00	1.42
instance n=1000 396.alb	1	0	Solution	30.30	138	136.00	1.45
instance n=1000 397.alb	1	0	Solution	30.14	142	140.00	1.41
instance n=1000 398.alb	1	0	Solution	30.11	136	134.00	1.47

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 399.alb	1	0	Solution	30.14	140	139.00	0.71
instance n=1000 4.alb	1	0	Solution	30.40	139	138.00	0.72
instance n=1000 40.alb	1	0	Solution	30.24	531	496.00	6.59
instance n=1000 400.alb	1	0	Solution	30.15	142	140.00	1.41
instance n=1000 401.alb	1	0	Solution	30.39	556	497.00	10.61
instance n=1000 402.alb	1	0	Solution	30.39	567	500.00	11.82
instance n=1000 403.alb	1	0	Solution	30.45	562	500.00	11.03
instance n=1000 404.alb	1	0	Solution	30.23	557	500.00	10.23
instance n=1000 405.alb	1	0	Solution	30.24	567	501.00	11.64
instance n=1000 406.alb	1	0	Solution	30.34	552	495.00	10.33
instance n=1000 407.alb	1	0	Solution	30.50	564	498.00	11.70
instance n=1000 408.alb	1	0	Solution	30.88	568	501.00	11.80
instance n=1000 409.alb	1	0	Solution	30.38	568	504.00	11.27
instance n=1000 41.alb	1	0	Solution	30.25	544	500.00	8.09
instance n=1000 410.alb	1	0	Solution	30.54	580	505.00	12.93
instance n=1000 411.alb	1	0	Solution	30.26	563	498.00	11.55
instance n=1000 412.alb	1	0	Solution	30.47	565	499.00	11.68
instance n=1000 413.alb	1	0	Solution	30.25	567	503.00	11.29
instance n=1000 414.alb	1	0	Solution	30.38	563	501.00	11.01
instance n=1000 415.alb	1	0	Solution	30.24	564	501.00	11.17
instance n=1000 416.alb	1	0	Solution	30.24	567	502.00	11.46
instance n=1000 417.alb	1	0	Solution	30.23	592	512.00	13.51
instance n=1000 418.alb	1	0	Solution	30.23	560	501.00	10.54
instance n=1000 419.alb	1	0	Solution	30.23	583	510.00	12.52
instance n=1000 42.alb	1	0	Solution	30.28	533	497.00	6.75
instance n=1000 420.alb	1	0	Solution	30.47	565	501.00	11.33
instance n=1000 421.alb	1	0	Solution	30.31	561	499.00	11.05
instance n=1000 422.alb	1	0	Solution	30.29	560	495.00	11.61
instance n=1000 423.alb	1	0	Solution	30.28	565	500.00	11.50
instance n=1000 424.alb	1	0	Solution	30.21	553	495.00	10.49
instance n=1000 425.alb	1	0	Solution	30.30	572	504.00	11.89
instance n=1000 426.alb	1	0	Solution	30.33	229	224.00	2.18
instance n=1000 427.alb	1	0	Solution	30.17	235	229.00	2.55
instance n=1000 428.alb	1	0	Solution	30.14	228	224.00	1.75
instance n=1000 429.alb	1	0	Solution	30.31	240	235.00	2.08
instance n=1000 43.alb	1	0	Solution	30.21	534	496.00	7.12
instance n=1000 430.alb	1	0	Solution	30.54	224	220.00	1.79
instance n=1000 431.alb	1	0	Solution	30.14	235	230.00	2.13
instance n=1000 432.alb	1	0	Solution	30.46	232	227.00	2.16
instance n=1000 433.alb	1	0	Solution	30.12	234	229.00	2.14
instance n=1000 434.alb	1	0	Solution	30.27	215	212.00	1.40
instance n=1000 435.alb	1	0	Solution	30.34	232	227.00	2.16
instance n=1000 436.alb	1	0	Solution	30.37	231	226.00	2.16
instance n=1000 437.alb	1	0	Solution	30.32	227	222.00	2.20
instance n=1000 438.alb	1	0	Solution	30.42	226	221.00	2.21

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 439.alb	1	0	Solution	30.12	230	225.00	2.17
instance n=1000 44.alb	1	0	Solution	30.33	552	502.00	9.06
instance n=1000 440.alb	1	0	Solution	30.18	230	225.00	2.17
instance n=1000 441.alb	1	0	Solution	30.66	226	221.00	2.21
instance n=1000 442.alb	1	0	Solution	30.48	235	230.00	2.13
instance n=1000 443.alb	1	0	Solution	30.15	222	217.00	2.25
instance n=1000 444.alb	1	0	Solution	30.14	227	222.00	2.20
instance n=1000 445.alb	1	0	Solution	30.37	235	229.00	2.55
instance n=1000 446.alb	1	0	Solution	30.12	233	228.00	2.15
instance n=1000 447.alb	1	0	Solution	30.15	227	221.00	2.64
instance n=1000 448.alb	1	0	Solution	30.70	226	222.00	1.77
instance n=1000 449.alb	1	0	Solution	30.18	238	232.00	2.52
instance n=1000 45.alb	1	0	Solution	30.43	524	492.00	6.11
instance n=1000 450.alb	1	0	Solution	30.43	225	220.00	2.22
instance n=1000 451.alb	1	0	Solution	30.12	140	136.00	2.86
instance n=1000 452.alb	1	0	Solution	30.19	135	132.00	2.22
instance n=1000 453.alb	1	0	Solution	30.36	141	138.00	2.13
instance n=1000 454.alb	1	0	Solution	30.15	142	139.00	2.11
instance n=1000 455.alb	1	0	Solution	30.22	140	136.00	2.86
instance n=1000 456.alb	1	0	Solution	30.14	138	135.00	2.17
instance n=1000 457.alb	1	0	Solution	30.61	140	137.00	2.14
instance n=1000 458.alb	1	0	Solution	30.46	138	135.00	2.17
instance n=1000 459.alb	1	0	Solution	30.23	140	137.00	2.14
instance n=1000 46.alb	1	0	Solution	30.21	538	498.00	7.43
instance n=1000 460.alb	1	0	Solution	30.15	141	138.00	2.13
instance n=1000 461.alb	1	0	Solution	30.37	140	137.00	2.14
instance n=1000 462.alb	1	0	Solution	30.32	139	136.00	2.16
instance n=1000 463.alb	1	0	Solution	30.51	138	136.00	1.45
instance n=1000 464.alb	1	0	Solution	30.15	141	138.00	2.13
instance n=1000 465.alb	1	0	Solution	30.72	141	138.00	2.13
instance n=1000 466.alb	1	0	Solution	31.19	137	133.00	2.92
instance n=1000 467.alb	1	0	Solution	30.56	140	138.00	1.43
instance n=1000 468.alb	1	0	Solution	30.62	140	137.00	2.14
instance n=1000 469.alb	1	0	Solution	30.17	140	137.00	2.14
instance n=1000 47.alb	1	0	Solution	30.56	542	499.00	7.93
instance n=1000 470.alb	1	0	Solution	30.15	138	135.00	2.17
instance n=1000 471.alb	1	0	Solution	30.45	138	135.00	2.17
instance n=1000 472.alb	1	0	Solution	30.27	143	140.00	2.10
instance n=1000 473.alb	1	0	Solution	30.10	138	135.00	2.17
instance n=1000 474.alb	1	0	Solution	30.43	139	136.00	2.16
instance n=1000 475.alb	1	0	Solution	30.57	139	136.00	2.16
instance n=1000 476.alb	1	0	Solution	30.28	588	503.00	14.46
instance n=1000 477.alb	1	0	Solution	30.37	594	507.00	14.65
instance n=1000 478.alb	1	0	Solution	30.51	604	510.00	15.56
instance n=1000 479.alb	1	0	Solution	30.53	590	503.00	14.75

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 48.alb	1	0	Solution	30.25	565	508.00	10.09
instance n=1000 480.alb	1	0	Solution	30.29	578	498.00	13.84
instance n=1000 481.alb	1	0	Solution	30.60	585	504.00	13.85
instance n=1000 482.alb	1	0	Solution	30.39	605	505.00	16.53
instance n=1000 483.alb	1	0	Solution	30.52	577	499.00	13.52
instance n=1000 484.alb	1	0	Solution	30.48	596	508.00	14.77
instance n=1000 485.alb	1	0	Solution	30.43	591	505.00	14.55
instance n=1000 486.alb	1	0	Solution	30.51	583	500.00	14.24
instance n=1000 487.alb	1	0	Solution	30.32	592	502.00	15.20
instance n=1000 488.alb	1	0	Solution	30.85	581	502.00	13.60
instance n=1000 489.alb	1	0	Solution	30.27	577	498.00	13.69
instance n=1000 49.alb	1	0	Solution	30.44	544	500.00	8.09
instance n=1000 490.alb	1	0	Solution	30.21	587	501.00	14.65
instance n=1000 491.alb	1	0	Solution	30.32	582	500.00	14.09
instance n=1000 492.alb	1	0	Solution	30.24	596	509.00	14.60
instance n=1000 493.alb	1	0	Solution	30.51	568	495.00	12.85
instance n=1000 494.alb	1	0	Solution	30.26	580	500.00	13.79
instance n=1000 495.alb	1	0	Solution	30.28	603	507.00	15.92
instance n=1000 496.alb	1	0	Solution	30.63	571	495.00	13.31
instance n=1000 497.alb	1	0	Solution	30.33	578	499.00	13.67
instance n=1000 498.alb	1	0	Solution	30.22	594	506.00	14.81
instance n=1000 499.alb	1	0	Solution	30.21	580	499.00	13.97
instance n=1000 5.alb	1	0	Solution	30.27	136	135.00	0.74
instance n=1000 50.alb	1	0	Solution	30.23	528	493.00	6.63
instance n=1000 500.alb	1	0	Solution	30.20	586	503.00	14.16
instance n=1000 501.alb	1	0	Solution	30.17	237	227.00	4.22
instance n=1000 502.alb	1	0	Solution	30.23	232	224.00	3.45
instance n=1000 503.alb	1	0	Solution	30.61	233	224.00	3.86
instance n=1000 504.alb	1	0	Solution	30.25	236	227.00	3.81
instance n=1000 505.alb	1	0	Solution	30.51	222	213.00	4.05
instance n=1000 506.alb	1	0	Solution	30.49	230	223.00	3.04
instance n=1000 507.alb	1	0	Solution	30.45	230	220.00	4.35
instance n=1000 508.alb	1	0	Solution	30.18	227	219.00	3.52
instance n=1000 509.alb	1	0	Solution	30.56	233	225.00	3.43
instance n=1000 51.alb	1	0	Solution	30.14	231	226.00	2.16
instance n=1000 510.alb	1	0	Solution	30.18	235	226.00	3.83
instance n=1000 511.alb	1	0	Solution	30.21	238	230.00	3.36
instance n=1000 512.alb	1	0	Solution	30.42	227	219.00	3.52
instance n=1000 513.alb	1	0	Solution	30.13	228	219.00	3.95
instance n=1000 514.alb	1	0	Solution	30.12	234	226.00	3.42
instance n=1000 515.alb	1	0	Solution	30.21	229	221.00	3.49
instance n=1000 516.alb	1	0	Solution	30.22	238	229.00	3.78
instance n=1000 517.alb	1	0	Solution	30.32	229	221.00	3.49
instance n=1000 518.alb	1	0	Solution	30.11	229	220.00	3.93
instance n=1000 519.alb	1	0	Solution	30.13	229	221.00	3.49

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 52.alb	1	0	Solution	30.12	232	228.00	1.72
instance n=1000 520.alb	1	0	Solution	30.46	235	226.00	3.83
instance n=1000 521.alb	1	0	Solution	30.28	239	229.00	4.18
instance n=1000 522.alb	1	0	Solution	30.54	222	215.00	3.15
instance n=1000 523.alb	1	0	Solution	30.11	228	220.00	3.51
instance n=1000 524.alb	1	0	Solution	30.55	233	225.00	3.43
instance n=1000 525.alb	1	0	Solution	30.22	230	221.00	3.91
instance n=1000 53.alb	1	0	Solution	30.36	230	227.00	1.30
instance n=1000 54.alb	1	0	Solution	30.39	223	219.00	1.79
instance n=1000 55.alb	1	0	Solution	30.34	220	217.00	1.36
instance n=1000 56.alb	1	0	Solution	30.42	232	228.00	1.72
instance n=1000 57.alb	1	0	Solution	30.13	227	224.00	1.32
instance n=1000 58.alb	1	0	Solution	30.16	227	224.00	1.32
instance n=1000 59.alb	1	0	Solution	30.13	226	223.00	1.33
instance n=1000 6.alb	1	0	Solution	30.21	143	141.00	1.40
instance n=1000 60.alb	1	0	Solution	30.18	234	230.00	1.71
instance n=1000 61.alb	1	0	Solution	30.26	233	229.00	1.72
instance n=1000 62.alb	1	0	Solution	30.72	227	223.00	1.76
instance n=1000 63.alb	1	0	Solution	30.48	230	227.00	1.30
instance n=1000 64.alb	1	0	Solution	30.22	233	229.00	1.72
instance n=1000 65.alb	1	0	Solution	30.83	227	225.00	0.88
instance n=1000 66.alb	1	0	Solution	30.14	230	227.00	1.30
instance n=1000 67.alb	1	0	Solution	30.42	227	223.00	1.76
instance n=1000 68.alb	1	0	Solution	30.39	231	226.00	2.16
instance n=1000 69.alb	1	0	Solution	30.13	227	224.00	1.32
instance n=1000 7.alb	1	0	Solution	30.45	138	136.00	1.45
instance n=1000 70.alb	1	0	Solution	30.35	231	228.00	1.30
instance n=1000 71.alb	1	0	Solution	30.24	233	230.00	1.29
instance n=1000 72.alb	1	0	Solution	30.43	226	222.00	1.77
instance n=1000 73.alb	1	0	Solution	30.36	224	221.00	1.34
instance n=1000 74.alb	1	0	Solution	30.42	231	227.00	1.73
instance n=1000 75.alb	1	0	Solution	30.43	231	227.00	1.73
instance n=1000 76.alb	1	0	Solution	30.28	137	136.00	0.73
instance n=1000 77.alb	1	0	Solution	30.19	137	136.00	0.73
instance n=1000 78.alb	1	0	Solution	30.16	140	138.00	1.43
instance n=1000 79.alb	1	0	Solution	30.45	143	142.00	0.70
instance n=1000 8.alb	1	0	Solution	30.34	140	138.00	1.43
instance n=1000 80.alb	1	0	Solution	30.46	141	140.00	0.71
instance n=1000 81.alb	1	0	Solution	30.41	138	136.00	1.45
instance n=1000 82.alb	1	0	Solution	30.31	137	136.00	0.73
instance n=1000 83.alb	1	0	Solution	30.36	141	140.00	0.71
instance n=1000 84.alb	1	0	Solution	30.13	136	135.00	0.74
instance n=1000 85.alb	1	0	Solution	30.34	138	136.00	1.45
instance n=1000 86.alb	1	0	Solution	30.80	139	138.00	0.72
instance n=1000 87.alb	1	0	Solution	30.08	142	140.00	1.41

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=1000 88.alb	1	0	Solution	30.32	142	140.00	1.41
instance n=1000 89.alb	1	0	Solution	30.46	142	140.00	1.41
instance n=1000 9.alb	1	0	Solution	30.45	136	134.00	1.47
instance n=1000 90.alb	1	0	Solution	30.61	139	138.00	0.72
instance n=1000 91.alb	1	0	Solution	30.35	142	141.00	0.70
instance n=1000 92.alb	1	0	Solution	30.40	137	136.00	0.73
instance n=1000 93.alb	1	0	Solution	30.09	138	137.00	0.72
instance n=1000 94.alb	1	0	Solution	30.11	139	137.00	1.44
instance n=1000 95.alb	1	0	Solution	30.20	137	136.00	0.73
instance n=1000 96.alb	1	0	Solution	30.39	139	137.00	1.44
instance n=1000 97.alb	1	0	Solution	30.18	140	138.00	1.43
instance n=1000 98.alb	1	0	Solution	30.37	137	136.00	0.73
instance n=1000 99.alb	1	0	Solution	30.57	137	136.00	0.73
instance n=100 1.alb	1	0	Solution	30.06	24	23.00	4.17
instance n=100 10.alb	1	0	Optimal	1.03	22	22.00	0.00
instance n=100 100.alb	1	0	Optimal	13.94	25	25.00	0.00
instance n=100 101.alb	1	0	Optimal	4.34	15	15.00	0.00
instance n=100 102.alb	1	0	Optimal	0.56	14	14.00	0.00
instance n=100 103.alb	1	0	Optimal	0.67	14	14.00	0.00
instance n=100 104.alb	1	0	Optimal	0.65	14	14.00	0.00
instance n=100 105.alb	1	0	Optimal	0.60	13	13.00	0.00
instance n=100 106.alb	1	0	Optimal	0.69	14	14.00	0.00
instance n=100 107.alb	1	0	Optimal	0.64	14	14.00	0.00
instance n=100 108.alb	1	0	Optimal	15.41	14	14.00	0.00
instance n=100 109.alb	1	0	Optimal	1.02	15	15.00	0.00
instance n=100 11.alb	1	0	Optimal	0.76	24	24.00	0.00
instance n=100 110.alb	1	0	Optimal	1.33	13	13.00	0.00
instance n=100 111.alb	1	0	Optimal	0.89	16	16.00	0.00
instance n=100 112.alb	1	0	Optimal	16.81	13	13.00	0.00
instance n=100 113.alb	1	0	Optimal	0.60	14	14.00	0.00
instance n=100 114.alb	1	0	Optimal	1.38	13	13.00	0.00
instance n=100 115.alb	1	0	Optimal	1.05	14	14.00	0.00
instance n=100 116.alb	1	0	Optimal	0.55	16	16.00	0.00
instance n=100 117.alb	1	0	Optimal	24.41	15	15.00	0.00
instance n=100 118.alb	1	0	Optimal	0.40	15	15.00	0.00
instance n=100 119.alb	1	0	Optimal	0.57	14	14.00	0.00
instance n=100 12.alb	1	0	Optimal	29.06	25	25.00	0.00
instance n=100 120.alb	1	0	Optimal	1.22	14	14.00	0.00
instance n=100 121.alb	1	0	Optimal	0.68	15	15.00	0.00
instance n=100 122.alb	1	0	Optimal	0.98	13	13.00	0.00
instance n=100 123.alb	1	0	Optimal	0.97	15	15.00	0.00
instance n=100 124.alb	1	0	Optimal	17.20	15	15.00	0.00
instance n=100 125.alb	1	0	Optimal	0.52	14	14.00	0.00
instance n=100 126.alb	1	0	Solution	30.11	53	49.00	7.55
instance n=100 127.alb	1	0	Solution	30.14	54	49.00	9.26

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 128.alb	1	0	Solution	30.08	58	52.00	10.34
instance n=100 129.alb	1	0	Solution	30.07	55	50.00	9.09
instance n=100 13.alb	1	0	Optimal	4.80	24	24.00	0.00
instance n=100 130.alb	1	0	Solution	30.07	56	51.00	8.93
instance n=100 131.alb	1	0	Solution	30.16	53	50.00	5.66
instance n=100 132.alb	1	0	Solution	30.10	59	52.00	11.86
instance n=100 133.alb	1	0	Solution	30.07	57	51.00	10.53
instance n=100 134.alb	1	0	Solution	30.10	57	51.00	10.53
instance n=100 135.alb	1	0	Solution	30.08	56	51.00	8.93
instance n=100 136.alb	1	0	Solution	30.14	53	49.00	7.55
instance n=100 137.alb	1	0	Solution	30.11	54	50.00	7.41
instance n=100 138.alb	1	0	Solution	30.10	57	52.00	8.77
instance n=100 139.alb	1	0	Solution	30.05	52	49.00	5.77
instance n=100 14.alb	1	0	Optimal	13.86	20	20.00	0.00
instance n=100 140.alb	1	0	Solution	30.05	55	51.00	7.27
instance n=100 141.alb	1	0	Solution	30.05	52	49.00	5.77
instance n=100 142.alb	1	0	Solution	30.13	56	50.00	10.71
instance n=100 143.alb	1	0	Solution	30.12	54	51.00	5.56
instance n=100 144.alb	1	0	Solution	30.11	49	47.00	4.08
instance n=100 145.alb	1	0	Solution	30.05	57	51.00	10.53
instance n=100 146.alb	1	0	Solution	30.12	53	50.00	5.66
instance n=100 147.alb	1	0	Solution	30.07	60	52.00	13.33
instance n=100 148.alb	1	0	Solution	30.11	53	50.00	5.66
instance n=100 149.alb	1	0	Solution	30.06	55	51.00	7.27
instance n=100 15.alb	1	0	Optimal	0.59	24	24.00	0.00
instance n=100 150.alb	1	0	Solution	30.03	58	51.00	12.07
instance n=100 151.alb	1	0	Solution	30.11	22	21.00	4.55
instance n=100 152.alb	1	0	Optimal	0.97	22	22.00	0.00
instance n=100 153.alb	1	0	Optimal	0.59	21	21.00	0.00
instance n=100 154.alb	1	0	Optimal	0.82	25	25.00	0.00
instance n=100 155.alb	1	0	Optimal	0.72	22	22.00	0.00
instance n=100 156.alb	1	0	Optimal	0.95	23	23.00	0.00
instance n=100 157.alb	1	0	Optimal	4.75	26	26.00	0.00
instance n=100 158.alb	1	0	Optimal	1.02	23	23.00	0.00
instance n=100 159.alb	1	0	Optimal	0.46	19	19.00	0.00
instance n=100 16.alb	1	0	Optimal	0.54	23	23.00	0.00
instance n=100 160.alb	1	0	Optimal	0.97	22	22.00	0.00
instance n=100 161.alb	1	0	Solution	30.06	23	22.00	4.35
instance n=100 162.alb	1	0	Solution	30.05	23	22.00	4.35
instance n=100 163.alb	1	0	Optimal	0.62	25	25.00	0.00
instance n=100 164.alb	1	0	Optimal	0.57	23	23.00	0.00
instance n=100 165.alb	1	0	Solution	30.04	25	24.00	4.00
instance n=100 166.alb	1	0	Optimal	7.70	24	24.00	0.00
instance n=100 167.alb	1	0	Optimal	0.96	22	22.00	0.00
instance n=100 168.alb	1	0	Solution	30.10	22	21.00	4.55

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 169.alb	1	0	Optimal	1.12	21	21.00	0.00
instance n=100 17.alb	1	0	Solution	30.08	22	21.00	4.55
instance n=100 170.alb	1	0	Optimal	15.42	24	24.00	0.00
instance n=100 171.alb	1	0	Solution	30.13	25	24.00	4.00
instance n=100 172.alb	1	0	Optimal	0.79	24	24.00	0.00
instance n=100 173.alb	1	0	Solution	30.07	25	24.00	4.00
instance n=100 174.alb	1	0	Optimal	15.49	22	22.00	0.00
instance n=100 175.alb	1	0	Solution	30.08	27	26.00	3.70
instance n=100 176.alb	1	0	Optimal	0.57	13	13.00	0.00
instance n=100 177.alb	1	0	Optimal	0.40	14	14.00	0.00
instance n=100 178.alb	1	0	Optimal	0.63	15	15.00	0.00
instance n=100 179.alb	1	0	Optimal	0.39	15	15.00	0.00
instance n=100 18.alb	1	0	Solution	30.10	20	19.00	5.00
instance n=100 180.alb	1	0	Optimal	0.64	15	15.00	0.00
instance n=100 181.alb	1	0	Optimal	0.51	13	13.00	0.00
instance n=100 182.alb	1	0	Optimal	0.61	15	15.00	0.00
instance n=100 183.alb	1	0	Optimal	0.61	14	14.00	0.00
instance n=100 184.alb	1	0	Optimal	0.80	14	14.00	0.00
instance n=100 185.alb	1	0	Optimal	0.89	15	15.00	0.00
instance n=100 186.alb	1	0	Optimal	6.82	14	14.00	0.00
instance n=100 187.alb	1	0	Solution	30.08	14	13.00	7.14
instance n=100 188.alb	1	0	Optimal	0.69	16	16.00	0.00
instance n=100 189.alb	1	0	Optimal	0.63	14	14.00	0.00
instance n=100 19.alb	1	0	Optimal	3.80	23	23.00	0.00
instance n=100 190.alb	1	0	Optimal	0.71	13	13.00	0.00
instance n=100 191.alb	1	0	Optimal	0.51	14	14.00	0.00
instance n=100 192.alb	1	0	Optimal	10.33	13	13.00	0.00
instance n=100 193.alb	1	0	Optimal	0.92	15	15.00	0.00
instance n=100 194.alb	1	0	Optimal	0.83	15	15.00	0.00
instance n=100 195.alb	1	0	Optimal	0.52	15	15.00	0.00
instance n=100 196.alb	1	0	Optimal	0.83	15	15.00	0.00
instance n=100 197.alb	1	0	Optimal	0.36	15	15.00	0.00
instance n=100 198.alb	1	0	Optimal	8.97	13	13.00	0.00
instance n=100 199.alb	1	0	Optimal	0.60	14	14.00	0.00
instance n=100 2.alb	1	0	Optimal	0.51	21	21.00	0.00
instance n=100 20.alb	1	0	Optimal	0.59	21	21.00	0.00
instance n=100 200.alb	1	0	Optimal	0.52	15	15.00	0.00
instance n=100 201.alb	1	0	Solution	30.04	55	51.00	7.27
instance n=100 202.alb	1	0	Solution	30.04	62	52.00	16.13
instance n=100 203.alb	1	0	Solution	30.11	53	49.00	7.55
instance n=100 204.alb	1	0	Solution	30.15	52	48.00	7.69
instance n=100 205.alb	1	0	Solution	30.10	58	51.00	12.07
instance n=100 206.alb	1	0	Solution	30.14	53	49.00	7.55
instance n=100 207.alb	1	0	Solution	30.10	52	49.00	5.77
instance n=100 208.alb	1	0	Solution	30.10	57	51.00	10.53

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 209.alb	1	0	Solution	30.09	56	51.00	8.93
instance n=100 21.alb	1	0	Optimal	4.37	21	21.00	0.00
instance n=100 210.alb	1	0	Solution	30.07	53	49.00	7.55
instance n=100 211.alb	1	0	Solution	30.10	53	49.00	7.55
instance n=100 212.alb	1	0	Solution	30.12	54	50.00	7.41
instance n=100 213.alb	1	0	Solution	30.08	54	50.00	7.41
instance n=100 214.alb	1	0	Solution	30.14	55	50.00	9.09
instance n=100 215.alb	1	0	Solution	30.12	51	47.00	7.84
instance n=100 216.alb	1	0	Solution	30.06	54	50.00	7.41
instance n=100 217.alb	1	0	Solution	30.08	53	49.00	7.55
instance n=100 218.alb	1	0	Solution	30.07	54	50.00	7.41
instance n=100 219.alb	1	0	Solution	30.10	53	49.00	7.55
instance n=100 22.alb	1	0	Solution	30.05	25	24.00	4.00
instance n=100 220.alb	1	0	Solution	30.16	54	50.00	7.41
instance n=100 221.alb	1	0	Solution	30.08	58	51.00	12.07
instance n=100 222.alb	1	0	Solution	30.14	54	50.00	7.41
instance n=100 223.alb	1	0	Solution	30.08	52	49.00	5.77
instance n=100 224.alb	1	0	Solution	30.14	56	51.00	8.93
instance n=100 225.alb	1	0	Solution	30.08	54	50.00	7.41
instance n=100 226.alb	1	0	Solution	30.05	25	24.00	4.00
instance n=100 227.alb	1	0	Solution	30.05	27	26.00	3.70
instance n=100 228.alb	1	0	Optimal	20.43	22	22.00	0.00
instance n=100 229.alb	1	0	Optimal	0.87	24	24.00	0.00
instance n=100 23.alb	1	0	Optimal	0.87	24	24.00	0.00
instance n=100 230.alb	1	0	Solution	30.10	24	23.00	4.17
instance n=100 231.alb	1	0	Solution	30.11	23	22.00	4.35
instance n=100 232.alb	1	0	Optimal	1.02	22	22.00	0.00
instance n=100 233.alb	1	0	Solution	30.13	23	22.00	4.35
instance n=100 234.alb	1	0	Optimal	0.63	23	23.00	0.00
instance n=100 235.alb	1	0	Optimal	6.48	26	26.00	0.00
instance n=100 236.alb	1	0	Solution	30.06	23	22.00	4.35
instance n=100 237.alb	1	0	Optimal	16.38	23	23.00	0.00
instance n=100 238.alb	1	0	Optimal	11.02	23	23.00	0.00
instance n=100 239.alb	1	0	Optimal	0.89	21	21.00	0.00
instance n=100 24.alb	1	0	Optimal	0.80	24	24.00	0.00
instance n=100 240.alb	1	0	Optimal	8.30	22	22.00	0.00
instance n=100 241.alb	1	0	Optimal	10.51	22	22.00	0.00
instance n=100 242.alb	1	0	Optimal	11.53	23	23.00	0.00
instance n=100 243.alb	1	0	Solution	30.12	24	23.00	4.17
instance n=100 244.alb	1	0	Optimal	0.81	21	21.00	0.00
instance n=100 245.alb	1	0	Solution	30.07	24	23.00	4.17
instance n=100 246.alb	1	0	Optimal	16.58	26	26.00	0.00
instance n=100 247.alb	1	0	Optimal	11.65	22	22.00	0.00
instance n=100 248.alb	1	0	Optimal	9.14	19	19.00	0.00
instance n=100 249.alb	1	0	Optimal	8.16	21	21.00	0.00

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 25.alb	1	0	Optimal	4.71	22	22.00	0.00
instance n=100 250.alb	1	0	Optimal	5.39	24	24.00	0.00
instance n=100 251.alb	1	0	Optimal	0.39	15	15.00	0.00
instance n=100 252.alb	1	0	Optimal	1.03	14	14.00	0.00
instance n=100 253.alb	1	0	Optimal	0.42	14	14.00	0.00
instance n=100 254.alb	1	0	Optimal	0.45	14	14.00	0.00
instance n=100 255.alb	1	0	Optimal	0.39	14	14.00	0.00
instance n=100 256.alb	1	0	Optimal	0.57	15	15.00	0.00
instance n=100 257.alb	1	0	Optimal	8.55	12	12.00	0.00
instance n=100 258.alb	1	0	Optimal	7.69	14	14.00	0.00
instance n=100 259.alb	1	0	Optimal	4.61	15	15.00	0.00
instance n=100 26.alb	1	0	Optimal	6.03	14	14.00	0.00
instance n=100 260.alb	1	0	Optimal	0.57	15	15.00	0.00
instance n=100 261.alb	1	0	Optimal	0.67	14	14.00	0.00
instance n=100 262.alb	1	0	Optimal	0.52	14	14.00	0.00
instance n=100 263.alb	1	0	Optimal	0.85	14	14.00	0.00
instance n=100 264.alb	1	0	Optimal	0.53	15	15.00	0.00
instance n=100 265.alb	1	0	Optimal	0.80	14	14.00	0.00
instance n=100 266.alb	1	0	Optimal	8.17	13	13.00	0.00
instance n=100 267.alb	1	0	Optimal	0.67	13	13.00	0.00
instance n=100 268.alb	1	0	Optimal	0.51	15	15.00	0.00
instance n=100 269.alb	1	0	Optimal	0.50	15	15.00	0.00
instance n=100 27.alb	1	0	Optimal	3.17	13	13.00	0.00
instance n=100 270.alb	1	0	Optimal	0.70	13	13.00	0.00
instance n=100 271.alb	1	0	Solution	30.06	14	13.00	7.14
instance n=100 272.alb	1	0	Optimal	0.45	14	14.00	0.00
instance n=100 273.alb	1	0	Optimal	18.30	13	13.00	0.00
instance n=100 274.alb	1	0	Optimal	8.78	13	13.00	0.00
instance n=100 275.alb	1	0	Optimal	0.69	13	13.00	0.00
instance n=100 276.alb	1	0	Solution	30.04	61	52.00	14.75
instance n=100 277.alb	1	0	Solution	30.11	58	51.00	12.07
instance n=100 278.alb	1	0	Solution	30.09	58	52.00	10.34
instance n=100 279.alb	1	0	Solution	30.10	55	50.00	9.09
instance n=100 28.alb	1	0	Optimal	4.73	14	14.00	0.00
instance n=100 280.alb	1	0	Solution	30.07	56	51.00	8.93
instance n=100 281.alb	1	0	Solution	30.10	62	52.00	16.13
instance n=100 282.alb	1	0	Solution	30.08	61	52.00	14.75
instance n=100 283.alb	1	0	Solution	30.11	56	50.00	10.71
instance n=100 284.alb	1	0	Solution	30.11	56	50.00	10.71
instance n=100 285.alb	1	0	Solution	30.08	55	50.00	9.09
instance n=100 286.alb	1	0	Solution	30.01	58	51.00	12.07
instance n=100 287.alb	1	0	Solution	30.11	55	50.00	9.09
instance n=100 288.alb	1	0	Solution	30.11	56	51.00	8.93
instance n=100 289.alb	1	0	Solution	30.10	62	52.00	16.13
instance n=100 29.alb	1	0	Optimal	3.16	14	14.00	0.00

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 290.alb	1	0	Solution	30.07	55	50.00	9.09
instance n=100 291.alb	1	0	Solution	30.06	53	49.00	7.55
instance n=100 292.alb	1	0	Solution	30.09	59	51.00	13.56
instance n=100 293.alb	1	0	Solution	30.10	53	49.00	7.55
instance n=100 294.alb	1	0	Solution	30.10	58	52.00	10.34
instance n=100 295.alb	1	0	Solution	30.09	57	51.00	10.53
instance n=100 296.alb	1	0	Solution	30.06	56	50.00	10.71
instance n=100 297.alb	1	0	Solution	30.11	59	51.00	13.56
instance n=100 298.alb	1	0	Solution	30.10	59	52.00	11.86
instance n=100 299.alb	1	0	Solution	30.09	56	50.00	10.71
instance n=100 3.alb	1	0	Optimal	1.01	20	20.00	0.00
instance n=100 30.alb	1	0	Optimal	0.39	15	15.00	0.00
instance n=100 300.alb	1	0	Solution	30.07	55	49.00	10.91
instance n=100 301.alb	1	0	Optimal	0.76	23	23.00	0.00
instance n=100 302.alb	1	0	Optimal	0.64	24	24.00	0.00
instance n=100 303.alb	1	0	Optimal	10.30	24	24.00	0.00
instance n=100 304.alb	1	0	Optimal	3.36	21	21.00	0.00
instance n=100 305.alb	1	0	Optimal	0.52	22	22.00	0.00
instance n=100 306.alb	1	0	Optimal	0.69	24	24.00	0.00
instance n=100 307.alb	1	0	Solution	30.06	24	23.00	4.17
instance n=100 308.alb	1	0	Solution	30.11	21	20.00	4.76
instance n=100 309.alb	1	0	Solution	30.12	22	21.00	4.55
instance n=100 31.alb	1	0	Optimal	0.73	14	14.00	0.00
instance n=100 310.alb	1	0	Optimal	4.85	23	23.00	0.00
instance n=100 311.alb	1	0	Optimal	0.58	21	21.00	0.00
instance n=100 312.alb	1	0	Optimal	0.67	22	22.00	0.00
instance n=100 313.alb	1	0	Optimal	0.98	23	23.00	0.00
instance n=100 314.alb	1	0	Optimal	1.00	19	19.00	0.00
instance n=100 315.alb	1	0	Solution	30.06	23	22.00	4.35
instance n=100 316.alb	1	0	Optimal	0.61	24	24.00	0.00
instance n=100 317.alb	1	0	Optimal	0.63	26	26.00	0.00
instance n=100 318.alb	1	0	Optimal	0.68	21	21.00	0.00
instance n=100 319.alb	1	0	Optimal	5.12	23	23.00	0.00
instance n=100 32.alb	1	0	Optimal	0.62	14	14.00	0.00
instance n=100 320.alb	1	0	Optimal	0.45	22	22.00	0.00
instance n=100 321.alb	1	0	Optimal	0.77	26	26.00	0.00
instance n=100 322.alb	1	0	Solution	30.05	24	23.00	4.17
instance n=100 323.alb	1	0	Optimal	0.53	24	24.00	0.00
instance n=100 324.alb	1	0	Optimal	0.76	23	23.00	0.00
instance n=100 325.alb	1	0	Solution	30.05	26	25.00	3.85
instance n=100 326.alb	1	0	Optimal	0.38	13	13.00	0.00
instance n=100 327.alb	1	0	Optimal	0.96	14	14.00	0.00
instance n=100 328.alb	1	0	Solution	30.08	15	14.00	6.67
instance n=100 329.alb	1	0	Optimal	0.61	14	14.00	0.00
instance n=100 33.alb	1	0	Optimal	1.88	15	15.00	0.00

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 330.alb	1	0	Optimal	20.57	14	14.00	0.00
instance n=100 331.alb	1	0	Optimal	0.38	14	14.00	0.00
instance n=100 332.alb	1	0	Optimal	0.48	14	14.00	0.00
instance n=100 333.alb	1	0	Optimal	0.53	15	15.00	0.00
instance n=100 334.alb	1	0	Optimal	5.87	14	14.00	0.00
instance n=100 335.alb	1	0	Optimal	0.41	13	13.00	0.00
instance n=100 336.alb	1	0	Optimal	0.64	15	15.00	0.00
instance n=100 337.alb	1	0	Optimal	1.12	13	13.00	0.00
instance n=100 338.alb	1	0	Solution	30.09	15	14.00	6.67
instance n=100 339.alb	1	0	Optimal	0.41	14	14.00	0.00
instance n=100 34.alb	1	0	Optimal	0.91	15	15.00	0.00
instance n=100 340.alb	1	0	Optimal	0.57	14	14.00	0.00
instance n=100 341.alb	1	0	Optimal	0.73	16	16.00	0.00
instance n=100 342.alb	1	0	Optimal	3.69	14	14.00	0.00
instance n=100 343.alb	1	0	Optimal	0.87	16	16.00	0.00
instance n=100 344.alb	1	0	Optimal	0.51	15	15.00	0.00
instance n=100 345.alb	1	0	Optimal	0.41	14	14.00	0.00
instance n=100 346.alb	1	0	Optimal	0.51	14	14.00	0.00
instance n=100 347.alb	1	0	Optimal	0.58	14	14.00	0.00
instance n=100 348.alb	1	0	Optimal	0.50	14	14.00	0.00
instance n=100 349.alb	1	0	Optimal	0.52	13	13.00	0.00
instance n=100 35.alb	1	0	Optimal	0.63	15	15.00	0.00
instance n=100 350.alb	1	0	Optimal	0.62	14	14.00	0.00
instance n=100 351.alb	1	0	Solution	30.12	60	52.00	13.33
instance n=100 352.alb	1	0	Solution	30.13	63	52.00	17.46
instance n=100 353.alb	1	0	Solution	30.06	53	49.00	7.55
instance n=100 354.alb	1	0	Solution	30.13	53	49.00	7.55
instance n=100 355.alb	1	0	Solution	30.11	56	51.00	8.93
instance n=100 356.alb	1	0	Solution	30.06	61	53.00	13.11
instance n=100 357.alb	1	0	Solution	30.11	54	50.00	7.41
instance n=100 358.alb	1	0	Solution	30.09	53	50.00	5.66
instance n=100 359.alb	1	0	Solution	30.13	54	50.00	7.41
instance n=100 36.alb	1	0	Optimal	19.30	14	14.00	0.00
instance n=100 360.alb	1	0	Solution	30.05	56	51.00	8.93
instance n=100 361.alb	1	0	Solution	30.10	53	49.00	7.55
instance n=100 362.alb	1	0	Solution	30.17	57	51.00	10.53
instance n=100 363.alb	1	0	Solution	30.13	54	50.00	7.41
instance n=100 364.alb	1	0	Solution	30.09	53	50.00	5.66
instance n=100 365.alb	1	0	Solution	30.15	55	50.00	9.09
instance n=100 366.alb	1	0	Solution	30.08	62	53.00	14.52
instance n=100 367.alb	1	0	Solution	30.09	57	51.00	10.53
instance n=100 368.alb	1	0	Solution	30.09	60	52.00	13.33
instance n=100 369.alb	1	0	Solution	30.11	52	49.00	5.77
instance n=100 37.alb	1	0	Optimal	0.91	14	14.00	0.00
instance n=100 370.alb	1	0	Solution	30.15	57	52.00	8.77

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 371.alb	1	0	Solution	30.07	53	50.00	5.66
instance n=100 372.alb	1	0	Solution	30.13	49	47.00	4.08
instance n=100 373.alb	1	0	Solution	30.07	52	49.00	5.77
instance n=100 374.alb	1	0	Solution	30.08	53	50.00	5.66
instance n=100 375.alb	1	0	Solution	30.15	58	52.00	10.34
instance n=100 376.alb	1	0	Optimal	0.84	23	23.00	0.00
instance n=100 377.alb	1	0	Solution	30.11	21	20.00	4.76
instance n=100 378.alb	1	0	Optimal	7.91	22	22.00	0.00
instance n=100 379.alb	1	0	Solution	30.05	24	23.00	4.17
instance n=100 38.alb	1	0	Optimal	1.10	14	14.00	0.00
instance n=100 380.alb	1	0	Solution	30.11	23	22.00	4.35
instance n=100 381.alb	1	0	Optimal	3.64	24	24.00	0.00
instance n=100 382.alb	1	0	Optimal	11.32	25	25.00	0.00
instance n=100 383.alb	1	0	Optimal	0.93	25	25.00	0.00
instance n=100 384.alb	1	0	Optimal	1.88	25	25.00	0.00
instance n=100 385.alb	1	0	Optimal	0.57	22	22.00	0.00
instance n=100 386.alb	1	0	Solution	30.05	24	23.00	4.17
instance n=100 387.alb	1	0	Optimal	1.40	22	22.00	0.00
instance n=100 388.alb	1	0	Solution	30.07	26	25.00	3.85
instance n=100 389.alb	1	0	Optimal	0.48	23	23.00	0.00
instance n=100 39.alb	1	0	Optimal	0.52	14	14.00	0.00
instance n=100 390.alb	1	0	Solution	30.09	23	22.00	4.35
instance n=100 391.alb	1	0	Optimal	0.55	20	20.00	0.00
instance n=100 392.alb	1	0	Optimal	0.57	22	22.00	0.00
instance n=100 393.alb	1	0	Solution	30.06	24	23.00	4.17
instance n=100 394.alb	1	0	Optimal	1.00	22	22.00	0.00
instance n=100 395.alb	1	0	Optimal	16.45	24	24.00	0.00
instance n=100 396.alb	1	0	Optimal	17.84	20	20.00	0.00
instance n=100 397.alb	1	0	Solution	30.09	26	25.00	3.85
instance n=100 398.alb	1	0	Solution	30.09	25	24.00	4.00
instance n=100 399.alb	1	0	Optimal	1.36	23	23.00	0.00
instance n=100 4.alb	1	0	Optimal	0.92	24	24.00	0.00
instance n=100 40.alb	1	0	Optimal	1.21	14	14.00	0.00
instance n=100 400.alb	1	0	Optimal	7.31	24	24.00	0.00
instance n=100 401.alb	1	0	Optimal	0.53	15	15.00	0.00
instance n=100 402.alb	1	0	Optimal	0.55	15	15.00	0.00
instance n=100 403.alb	1	0	Optimal	0.73	14	14.00	0.00
instance n=100 404.alb	1	0	Optimal	0.78	15	15.00	0.00
instance n=100 405.alb	1	0	Optimal	0.52	13	13.00	0.00
instance n=100 406.alb	1	0	Optimal	0.69	14	14.00	0.00
instance n=100 407.alb	1	0	Optimal	0.97	15	15.00	0.00
instance n=100 408.alb	1	0	Optimal	0.86	14	14.00	0.00
instance n=100 409.alb	1	0	Optimal	0.43	15	15.00	0.00
instance n=100 41.alb	1	0	Optimal	1.09	13	13.00	0.00
instance n=100 410.alb	1	0	Optimal	0.40	14	14.00	0.00

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 411.alb	1	0	Optimal	6.00	14	14.00	0.00
instance n=100 412.alb	1	0	Optimal	0.61	14	14.00	0.00
instance n=100 413.alb	1	0	Optimal	0.84	14	14.00	0.00
instance n=100 414.alb	1	0	Solution	30.12	15	14.00	6.67
instance n=100 415.alb	1	0	Optimal	6.42	13	13.00	0.00
instance n=100 416.alb	1	0	Optimal	0.61	14	14.00	0.00
instance n=100 417.alb	1	0	Optimal	0.62	15	15.00	0.00
instance n=100 418.alb	1	0	Optimal	0.75	16	16.00	0.00
instance n=100 419.alb	1	0	Optimal	6.36	14	14.00	0.00
instance n=100 42.alb	1	0	Optimal	0.46	14	14.00	0.00
instance n=100 420.alb	1	0	Optimal	0.43	14	14.00	0.00
instance n=100 421.alb	1	0	Optimal	0.38	14	14.00	0.00
instance n=100 422.alb	1	0	Optimal	0.58	15	15.00	0.00
instance n=100 423.alb	1	0	Optimal	5.44	14	14.00	0.00
instance n=100 424.alb	1	0	Optimal	0.51	14	14.00	0.00
instance n=100 425.alb	1	0	Optimal	0.59	15	15.00	0.00
instance n=100 426.alb	1	0	Solution	30.10	61	53.00	13.11
instance n=100 427.alb	1	0	Solution	30.08	56	50.00	10.71
instance n=100 428.alb	1	0	Solution	30.16	55	50.00	9.09
instance n=100 429.alb	1	0	Solution	30.08	59	52.00	11.86
instance n=100 43.alb	1	0	Optimal	7.35	14	14.00	0.00
instance n=100 430.alb	1	0	Solution	30.05	55	50.00	9.09
instance n=100 431.alb	1	0	Solution	30.08	54	50.00	7.41
instance n=100 432.alb	1	0	Solution	30.11	56	51.00	8.93
instance n=100 433.alb	1	0	Solution	30.09	54	49.00	9.26
instance n=100 434.alb	1	0	Solution	30.08	57	51.00	10.53
instance n=100 435.alb	1	0	Solution	30.09	57	50.00	12.28
instance n=100 436.alb	1	0	Solution	30.10	52	48.00	7.69
instance n=100 437.alb	1	0	Solution	30.08	54	50.00	7.41
instance n=100 438.alb	1	0	Solution	30.10	56	51.00	8.93
instance n=100 439.alb	1	0	Solution	30.11	56	51.00	8.93
instance n=100 44.alb	1	0	Optimal	0.52	14	14.00	0.00
instance n=100 440.alb	1	0	Solution	30.10	54	49.00	9.26
instance n=100 441.alb	1	0	Solution	30.07	53	50.00	5.66
instance n=100 442.alb	1	0	Solution	30.10	53	48.00	9.43
instance n=100 443.alb	1	0	Solution	30.08	56	50.00	10.71
instance n=100 444.alb	1	0	Solution	30.08	54	50.00	7.41
instance n=100 445.alb	1	0	Solution	30.09	56	51.00	8.93
instance n=100 446.alb	1	0	Solution	30.07	58	52.00	10.34
instance n=100 447.alb	1	0	Solution	30.13	55	50.00	9.09
instance n=100 448.alb	1	0	Solution	30.09	56	51.00	8.93
instance n=100 449.alb	1	0	Solution	30.02	56	50.00	10.71
instance n=100 45.alb	1	0	Optimal	0.37	14	14.00	0.00
instance n=100 450.alb	1	0	Solution	30.04	55	50.00	9.09
instance n=100 451.alb	1	0	Optimal	6.00	26	26.00	0.00

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 452.alb	1	0	Optimal	4.68	22	22.00	0.00
instance n=100 453.alb	1	0	Optimal	3.91	24	24.00	0.00
instance n=100 454.alb	1	0	Optimal	2.59	23	23.00	0.00
instance n=100 455.alb	1	0	Optimal	5.54	23	23.00	0.00
instance n=100 456.alb	1	0	Optimal	5.37	26	26.00	0.00
instance n=100 457.alb	1	0	Optimal	3.62	23	23.00	0.00
instance n=100 458.alb	1	0	Optimal	3.43	24	24.00	0.00
instance n=100 459.alb	1	0	Optimal	4.82	23	23.00	0.00
instance n=100 46.alb	1	0	Optimal	0.53	14	14.00	0.00
instance n=100 460.alb	1	0	Optimal	8.66	23	23.00	0.00
instance n=100 461.alb	1	0	Optimal	4.16	23	23.00	0.00
instance n=100 462.alb	1	0	Optimal	6.39	23	23.00	0.00
instance n=100 463.alb	1	0	Optimal	2.11	26	26.00	0.00
instance n=100 464.alb	1	0	Optimal	6.64	25	25.00	0.00
instance n=100 465.alb	1	0	Optimal	5.46	22	22.00	0.00
instance n=100 466.alb	1	0	Optimal	4.48	26	25.00	3.85
instance n=100 467.alb	1	0	Optimal	9.65	21	21.00	0.00
instance n=100 468.alb	1	0	Optimal	12.82	25	25.00	0.00
instance n=100 469.alb	1	0	Optimal	2.14	22	22.00	0.00
instance n=100 47.alb	1	0	Optimal	0.75	14	14.00	0.00
instance n=100 470.alb	1	0	Solution	30.14	26	25.00	3.85
instance n=100 471.alb	1	0	Optimal	9.86	26	26.00	0.00
instance n=100 472.alb	1	0	Optimal	0.96	23	23.00	0.00
instance n=100 473.alb	1	0	Optimal	3.97	28	28.00	0.00
instance n=100 474.alb	1	0	Optimal	2.22	23	23.00	0.00
instance n=100 475.alb	1	0	Solution	30.08	24	23.00	4.17
instance n=100 476.alb	1	0	Optimal	0.51	14	14.00	0.00
instance n=100 477.alb	1	0	Optimal	0.60	14	14.00	0.00
instance n=100 478.alb	1	0	Optimal	0.88	14	14.00	0.00
instance n=100 479.alb	1	0	Optimal	1.24	16	16.00	0.00
instance n=100 48.alb	1	0	Optimal	0.99	15	15.00	0.00
instance n=100 480.alb	1	0	Optimal	1.44	15	15.00	0.00
instance n=100 481.alb	1	0	Optimal	2.38	15	15.00	0.00
instance n=100 482.alb	1	0	Optimal	3.00	15	15.00	0.00
instance n=100 483.alb	1	0	Optimal	1.67	14	14.00	0.00
instance n=100 484.alb	1	0	Optimal	0.62	14	14.00	0.00
instance n=100 485.alb	1	0	Optimal	2.32	16	16.00	0.00
instance n=100 486.alb	1	0	Optimal	0.93	15	15.00	0.00
instance n=100 487.alb	1	0	Optimal	2.43	15	15.00	0.00
instance n=100 488.alb	1	0	Optimal	1.30	16	16.00	0.00
instance n=100 489.alb	1	0	Optimal	4.18	13	13.00	0.00
instance n=100 49.alb	1	0	Optimal	0.73	14	14.00	0.00
instance n=100 490.alb	1	0	Optimal	1.28	15	15.00	0.00
instance n=100 491.alb	1	0	Optimal	1.69	16	16.00	0.00
instance n=100 492.alb	1	0	Optimal	3.23	14	14.00	0.00

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 493.alb	1	0	Optimal	1.92	14	14.00	0.00
instance n=100 494.alb	1	0	Optimal	0.77	14	14.00	0.00
instance n=100 495.alb	1	0	Optimal	1.87	15	15.00	0.00
instance n=100 496.alb	1	0	Optimal	1.21	14	14.00	0.00
instance n=100 497.alb	1	0	Optimal	0.56	13	13.00	0.00
instance n=100 498.alb	1	0	Optimal	1.12	14	14.00	0.00
instance n=100 499.alb	1	0	Optimal	1.46	14	14.00	0.00
instance n=100 5.alb	1	0	Optimal	1.08	22	22.00	0.00
instance n=100 50.alb	1	0	Optimal	0.63	14	14.00	0.00
instance n=100 500.alb	1	0	Optimal	0.72	14	14.00	0.00
instance n=100 501.alb	1	0	Solution	30.10	63	58.00	7.94
instance n=100 502.alb	1	0	Solution	30.05	64	59.00	7.81
instance n=100 503.alb	1	0	Solution	30.08	60	55.00	8.33
instance n=100 504.alb	1	0	Solution	30.12	60	57.00	5.00
instance n=100 505.alb	1	0	Solution	30.05	61	52.00	14.75
instance n=100 506.alb	1	0	Solution	30.06	59	53.00	10.17
instance n=100 507.alb	1	0	Solution	30.09	59	55.00	6.78
instance n=100 508.alb	1	0	Solution	30.12	56	55.00	1.79
instance n=100 509.alb	1	0	Solution	30.10	57	54.00	5.26
instance n=100 51.alb	1	0	Solution	30.11	51	48.00	5.88
instance n=100 510.alb	1	0	Solution	30.11	58	54.00	6.90
instance n=100 511.alb	1	0	Solution	30.10	60	55.00	8.33
instance n=100 512.alb	1	0	Solution	30.08	60	54.00	10.00
instance n=100 513.alb	1	0	Solution	30.09	62	54.00	12.90
instance n=100 514.alb	1	0	Solution	30.09	58	53.00	8.62
instance n=100 515.alb	1	0	Solution	30.05	61	55.00	9.84
instance n=100 516.alb	1	0	Solution	30.03	70	59.00	15.71
instance n=100 517.alb	1	0	Solution	30.10	62	56.00	9.68
instance n=100 518.alb	1	0	Solution	30.09	57	52.00	8.77
instance n=100 519.alb	1	0	Solution	30.05	61	56.00	8.20
instance n=100 52.alb	1	0	Solution	30.05	53	50.00	5.66
instance n=100 520.alb	1	0	Solution	30.11	60	56.00	6.67
instance n=100 521.alb	1	0	Solution	30.12	70	61.00	12.86
instance n=100 522.alb	1	0	Solution	30.10	59	53.00	10.17
instance n=100 523.alb	1	0	Solution	30.11	55	53.00	3.64
instance n=100 524.alb	1	0	Solution	30.07	59	53.00	10.17
instance n=100 525.alb	1	0	Solution	30.10	62	54.00	12.90
instance n=100 53.alb	1	0	Solution	30.06	53	50.00	5.66
instance n=100 54.alb	1	0	Solution	30.06	52	49.00	5.77
instance n=100 55.alb	1	0	Solution	30.12	54	50.00	7.41
instance n=100 56.alb	1	0	Solution	30.07	53	50.00	5.66
instance n=100 57.alb	1	0	Solution	30.05	55	51.00	7.27
instance n=100 58.alb	1	0	Solution	30.13	58	52.00	10.34
instance n=100 59.alb	1	0	Solution	30.09	58	51.00	12.07
instance n=100 6.alb	1	0	Optimal	3.68	22	22.00	0.00

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=100 60.alb	1	0	Solution	30.11	54	51.00	5.56
instance n=100 61.alb	1	0	Solution	30.10	56	51.00	8.93
instance n=100 62.alb	1	0	Solution	30.13	53	49.00	7.55
instance n=100 63.alb	1	0	Solution	30.07	61	52.00	14.75
instance n=100 64.alb	1	0	Solution	30.11	57	51.00	10.53
instance n=100 65.alb	1	0	Solution	30.06	62	53.00	14.52
instance n=100 66.alb	1	0	Solution	30.08	52	49.00	5.77
instance n=100 67.alb	1	0	Solution	30.13	56	51.00	8.93
instance n=100 68.alb	1	0	Solution	30.06	57	49.00	14.04
instance n=100 69.alb	1	0	Solution	30.05	54	51.00	5.56
instance n=100 7.alb	1	0	Optimal	0.54	26	26.00	0.00
instance n=100 70.alb	1	0	Solution	30.08	55	50.00	9.09
instance n=100 71.alb	1	0	Solution	30.12	54	50.00	7.41
instance n=100 72.alb	1	0	Solution	30.08	55	50.00	9.09
instance n=100 73.alb	1	0	Solution	30.10	56	52.00	7.14
instance n=100 74.alb	1	0	Solution	30.11	53	49.00	7.55
instance n=100 75.alb	1	0	Solution	30.06	56	51.00	8.93
instance n=100 76.alb	1	0	Optimal	0.98	23	23.00	0.00
instance n=100 77.alb	1	0	Optimal	0.61	20	20.00	0.00
instance n=100 78.alb	1	0	Optimal	20.10	21	21.00	0.00
instance n=100 79.alb	1	0	Optimal	0.81	21	21.00	0.00
instance n=100 8.alb	1	0	Optimal	0.92	24	24.00	0.00
instance n=100 80.alb	1	0	Optimal	11.62	22	22.00	0.00
instance n=100 81.alb	1	0	Optimal	16.85	20	20.00	0.00
instance n=100 82.alb	1	0	Optimal	5.11	21	21.00	0.00
instance n=100 83.alb	1	0	Optimal	0.56	22	22.00	0.00
instance n=100 84.alb	1	0	Solution	30.06	27	26.00	3.70
instance n=100 85.alb	1	0	Solution	30.06	25	24.00	4.00
instance n=100 86.alb	1	0	Optimal	2.08	23	23.00	0.00
instance n=100 87.alb	1	0	Optimal	0.54	22	22.00	0.00
instance n=100 88.alb	1	0	Solution	30.11	24	23.00	4.17
instance n=100 89.alb	1	0	Optimal	6.82	24	24.00	0.00
instance n=100 9.alb	1	0	Solution	30.11	24	23.00	4.17
instance n=100 90.alb	1	0	Solution	30.11	21	20.00	4.76
instance n=100 91.alb	1	0	Optimal	0.85	25	25.00	0.00
instance n=100 92.alb	1	0	Optimal	0.64	24	24.00	0.00
instance n=100 93.alb	1	0	Optimal	28.85	27	27.00	0.00
instance n=100 94.alb	1	0	Optimal	24.95	22	22.00	0.00
instance n=100 95.alb	1	0	Optimal	6.49	21	21.00	0.00
instance n=100 96.alb	1	0	Optimal	7.38	21	21.00	0.00
instance n=100 97.alb	1	0	Optimal	5.11	22	22.00	0.00
instance n=100 98.alb	1	0	Optimal	1.71	22	22.00	0.00
instance n=100 99.alb	1	0	Optimal	0.72	22	22.00	0.00
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 6.1: Results for SALBP-1 Problems (CPO) (2100 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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

6.2 Results for CPSat

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 1.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 10.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 100.alb	1	0	Optimal	0.06	11	11.00	0.00
instance n=20 101.alb	1	0	Optimal	0.09	13	13.00	0.00
instance n=20 102.alb	1	0	Optimal	0.04	13	13.00	0.00
instance n=20 103.alb	1	0	Optimal	0.07	12	12.00	0.00
instance n=20 104.alb	1	0	Optimal	0.01	11	11.00	0.00
instance n=20 105.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=20 106.alb	1	0	Optimal	0.08	10	10.00	0.00
instance n=20 107.alb	1	0	Optimal	0.14	14	14.00	0.00
instance n=20 108.alb	1	0	Optimal	0.02	15	15.00	0.00
instance n=20 109.alb	1	0	Optimal	0.04	12	12.00	0.00
instance n=20 11.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 110.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 111.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=20 112.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 113.alb	1	0	Optimal	0.05	12	12.00	0.00
instance n=20 114.alb	1	0	Optimal	0.05	13	13.00	0.00
instance n=20 115.alb	1	0	Optimal	0.01	11	11.00	0.00
instance n=20 116.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 117.alb	1	0	Optimal	0.02	5	5.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 118.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 119.alb	1	0	Optimal	0.02	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	0.02	6	6.00	0.00
instance n=20 121.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 122.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 123.alb	1	0	Optimal	0.01	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	0.02	5	5.00	0.00
instance n=20 126.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 127.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 128.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 129.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 13.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 130.alb	1	0	Optimal	0.02	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	0.02	4	4.00	0.00
instance n=20 133.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 134.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 135.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 136.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 137.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 138.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 139.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 14.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 140.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 141.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 142.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 143.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 144.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 145.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 146.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 147.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 148.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 149.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 15.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 150.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 151.alb	1	0	Optimal	0.01	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	0.01	3	3.00	0.00
instance n=20 154.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 155.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 156.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 157.alb	1	0	Optimal	0.02	3	3.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 158.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 159.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 16.alb	1	0	Optimal	0.15	12	12.00	0.00
instance n=20 160.alb	1	0	Optimal	0.02	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	0.02	3	3.00	0.00
instance n=20 163.alb	1	0	Optimal	0.02	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	0.01	3	3.00	0.00
instance n=20 166.alb	1	0	Optimal	0.52	12	12.00	0.00
instance n=20 167.alb	1	0	Optimal	0.30	11	11.00	0.00
instance n=20 168.alb	1	0	Optimal	0.02	10	10.00	0.00
instance n=20 169.alb	1	0	Optimal	0.12	11	11.00	0.00
instance n=20 17.alb	1	0	Optimal	0.08	10	10.00	0.00
instance n=20 170.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 171.alb	1	0	Optimal	0.85	13	13.00	0.00
instance n=20 172.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=20 173.alb	1	0	Optimal	0.10	11	11.00	0.00
instance n=20 174.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 175.alb	1	0	Optimal	0.05	10	10.00	0.00
instance n=20 176.alb	1	0	Optimal	0.14	11	11.00	0.00
instance n=20 177.alb	1	0	Optimal	0.29	10	10.00	0.00
instance n=20 178.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 179.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 18.alb	1	0	Optimal	0.07	11	11.00	0.00
instance n=20 180.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=20 181.alb	1	0	Optimal	0.06	11	11.00	0.00
instance n=20 182.alb	1	0	Optimal	0.27	11	11.00	0.00
instance n=20 183.alb	1	0	Optimal	0.44	13	13.00	0.00
instance n=20 184.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 185.alb	1	0	Optimal	0.02	15	15.00	0.00
instance n=20 186.alb	1	0	Optimal	0.63	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	0.15	11	11.00	0.00
instance n=20 189.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=20 19.alb	1	0	Optimal	0.04	14	14.00	0.00
instance n=20 190.alb	1	0	Optimal	0.36	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	0.02	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	0.08	6	6.00	0.00
instance n=20 195.alb	1	0	Optimal	0.10	6	6.00	0.00
instance n=20 196.alb	1	0	Optimal	0.05	5	5.00	0.00
instance n=20 197.alb	1	0	Optimal	0.02	4	4.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 198.alb	1	0	Optimal	0.05	6	6.00	0.00
instance n=20 199.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 2.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 20.alb	1	0	Optimal	0.13	11	11.00	0.00
instance n=20 200.alb	1	0	Optimal	0.16	6	6.00	0.00
instance n=20 201.alb	1	0	Optimal	0.18	6	6.00	0.00
instance n=20 202.alb	1	0	Optimal	0.04	4	4.00	0.00
instance n=20 203.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 204.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 205.alb	1	0	Optimal	0.10	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	0.09	6	6.00	0.00
instance n=20 208.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 209.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 21.alb	1	0	Optimal	0.02	14	14.00	0.00
instance n=20 210.alb	1	0	Optimal	0.06	5	5.00	0.00
instance n=20 211.alb	1	0	Optimal	0.09	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	0.04	5	5.00	0.00
instance n=20 214.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 215.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 216.alb	1	0	Optimal	0.01	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	0.01	3	3.00	0.00
instance n=20 22.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=20 220.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 221.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 222.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 223.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 224.alb	1	0	Optimal	0.01	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	0.01	3	3.00	0.00
instance n=20 228.alb	1	0	Optimal	0.21	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	0.64	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	0.01	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	0.01	3	3.00	0.00
instance n=20 236.alb	1	0	Optimal	0.01	3	3.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 237.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 238.alb	1	0	Optimal	0.03	3	3.00	0.00
instance n=20 239.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 24.alb	1	0	Optimal	0.02	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	0.04	13	13.00	0.00
instance n=20 242.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 243.alb	1	0	Optimal	0.06	10	10.00	0.00
instance n=20 244.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=20 245.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 246.alb	1	0	Optimal	0.06	13	13.00	0.00
instance n=20 247.alb	1	0	Optimal	0.06	11	11.00	0.00
instance n=20 248.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 249.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=20 25.alb	1	0	Optimal	0.11	11	11.00	0.00
instance n=20 250.alb	1	0	Optimal	0.03	10	10.00	0.00
instance n=20 251.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 252.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=20 253.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=20 254.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=20 255.alb	1	0	Optimal	0.04	13	13.00	0.00
instance n=20 256.alb	1	0	Optimal	0.02	14	14.00	0.00
instance n=20 257.alb	1	0	Optimal	0.06	10	10.00	0.00
instance n=20 258.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 259.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=20 26.alb	1	0	Optimal	0.01	12	12.00	0.00
instance n=20 260.alb	1	0	Optimal	0.01	12	12.00	0.00
instance n=20 261.alb	1	0	Optimal	0.04	12	12.00	0.00
instance n=20 262.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=20 263.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 264.alb	1	0	Optimal	0.06	12	12.00	0.00
instance n=20 265.alb	1	0	Optimal	0.04	12	12.00	0.00
instance n=20 266.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 267.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 268.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 269.alb	1	0	Optimal	0.06	7	7.00	0.00
instance n=20 27.alb	1	0	Optimal	0.12	13	13.00	0.00
instance n=20 270.alb	1	0	Optimal	0.04	7	7.00	0.00
instance n=20 271.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 272.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 273.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 274.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 275.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 276.alb	1	0	Optimal	0.01	4	4.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 277.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 278.alb	1	0	Optimal	0.03	6	6.00	0.00
instance n=20 279.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 28.alb	1	0	Optimal	0.01	12	12.00	0.00
instance n=20 280.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 281.alb	1	0	Optimal	0.01	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	0.01	5	5.00	0.00
instance n=20 285.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 286.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 287.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 288.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 289.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 29.alb	1	0	Optimal	1.02	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	0.02	3	3.00	0.00
instance n=20 292.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 293.alb	1	0	Optimal	0.01	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	0.02	3	3.00	0.00
instance n=20 296.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 297.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 298.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 299.alb	1	0	Optimal	0.02	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	0.31	16	16.00	0.00
instance n=20 300.alb	1	0	Optimal	0.05	4	4.00	0.00
instance n=20 301.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 302.alb	1	0	Optimal	0.03	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	0.02	3	3.00	0.00
instance n=20 308.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 309.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 31.alb	1	0	Optimal	0.06	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	0.02	3	3.00	0.00
instance n=20 312.alb	1	0	Optimal	0.04	4	4.00	0.00
instance n=20 313.alb	1	0	Optimal	0.02	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	0.01	3	3.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 316.alb	1	0	Optimal	0.82	10	10.00	0.00
instance n=20 317.alb	1	0	Optimal	0.56	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	0.27	14	14.00	0.00
instance n=20 32.alb	1	0	Optimal	0.36	13	13.00	0.00
instance n=20 320.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 321.alb	1	0	Optimal	0.26	14	14.00	0.00
instance n=20 322.alb	1	0	Optimal	0.66	12	12.00	0.00
instance n=20 323.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=20 324.alb	1	0	Optimal	0.44	9	9.00	0.00
instance n=20 325.alb	1	0	Optimal	0.02	14	14.00	0.00
instance n=20 326.alb	1	0	Optimal	0.26	14	14.00	0.00
instance n=20 327.alb	1	0	Optimal	0.86	13	13.00	0.00
instance n=20 328.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=20 329.alb	1	0	Optimal	0.13	10	10.00	0.00
instance n=20 33.alb	1	0	Optimal	0.10	11	11.00	0.00
instance n=20 330.alb	1	0	Optimal	0.13	12	12.00	0.00
instance n=20 331.alb	1	0	Optimal	1.22	13	13.00	0.00
instance n=20 332.alb	1	0	Optimal	0.21	13	13.00	0.00
instance n=20 333.alb	1	0	Optimal	0.08	11	11.00	0.00
instance n=20 334.alb	1	0	Optimal	0.09	10	10.00	0.00
instance n=20 335.alb	1	0	Optimal	0.02	14	14.00	0.00
instance n=20 336.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 337.alb	1	0	Optimal	0.13	10	10.00	0.00
instance n=20 338.alb	1	0	Optimal	0.24	14	14.00	0.00
instance n=20 339.alb	1	0	Optimal	0.02	13	13.00	0.00
instance n=20 34.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 340.alb	1	0	Optimal	0.08	11	11.00	0.00
instance n=20 341.alb	1	0	Optimal	0.10	6	6.00	0.00
instance n=20 342.alb	1	0	Optimal	0.05	6	6.00	0.00
instance n=20 343.alb	1	0	Optimal	0.29	6	6.00	0.00
instance n=20 344.alb	1	0	Optimal	0.04	6	6.00	0.00
instance n=20 345.alb	1	0	Optimal	0.02	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	0.29	6	6.00	0.00
instance n=20 348.alb	1	0	Optimal	0.02	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	0.03	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	0.06	5	5.00	0.00
instance n=20 352.alb	1	0	Optimal	0.01	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	0.15	6	6.00	0.00
instance n=20 355.alb	1	0	Optimal	0.03	5	5.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 356.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 357.alb	1	0	Optimal	0.04	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	0.02	4	4.00	0.00
instance n=20 36.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 360.alb	1	0	Optimal	0.11	6	6.00	0.00
instance n=20 361.alb	1	0	Optimal	0.04	5	5.00	0.00
instance n=20 362.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 363.alb	1	0	Optimal	0.55	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	0.04	5	5.00	0.00
instance n=20 366.alb	1	0	Optimal	0.17	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	0.02	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	0.01	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	0.02	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	0.03	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	0.02	4	4.00	0.00
instance n=20 38.alb	1	0	Optimal	0.02	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	0.01	3	3.00	0.00
instance n=20 382.alb	1	0	Optimal	0.01	4	4.00	0.00
instance n=20 383.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 384.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 385.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 386.alb	1	0	Optimal	0.18	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	0.02	3	3.00	0.00
instance n=20 389.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 39.alb	1	0	Optimal	0.04	13	13.00	0.00
instance n=20 390.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 391.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=20 392.alb	1	0	Optimal	0.07	14	14.00	0.00
instance n=20 393.alb	1	0	Optimal	0.06	11	11.00	0.00
instance n=20 394.alb	1	0	Optimal	0.07	12	12.00	0.00
instance n=20 395.alb	1	0	Optimal	0.02	12	12.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 396.alb	1	0	Optimal	0.07	13	13.00	0.00
instance n=20 397.alb	1	0	Optimal	0.06	10	10.00	0.00
instance n=20 398.alb	1	0	Optimal	0.02	11	11.00	0.00
instance n=20 399.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 4.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 40.alb	1	0	Optimal	0.23	12	12.00	0.00
instance n=20 400.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 401.alb	1	0	Optimal	0.07	12	12.00	0.00
instance n=20 402.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 403.alb	1	0	Optimal	0.20	12	12.00	0.00
instance n=20 404.alb	1	0	Optimal	0.07	10	10.00	0.00
instance n=20 405.alb	1	0	Optimal	0.04	12	12.00	0.00
instance n=20 406.alb	1	0	Optimal	0.02	14	14.00	0.00
instance n=20 407.alb	1	0	Optimal	0.02	10	10.00	0.00
instance n=20 408.alb	1	0	Optimal	0.03	14	14.00	0.00
instance n=20 409.alb	1	0	Optimal	0.06	12	12.00	0.00
instance n=20 41.alb	1	0	Optimal	0.07	6	6.00	0.00
instance n=20 410.alb	1	0	Optimal	0.04	11	11.00	0.00
instance n=20 411.alb	1	0	Optimal	0.09	15	15.00	0.00
instance n=20 412.alb	1	0	Optimal	0.04	11	11.00	0.00
instance n=20 413.alb	1	0	Optimal	0.02	10	10.00	0.00
instance n=20 414.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=20 415.alb	1	0	Optimal	0.04	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	0.02	4	4.00	0.00
instance n=20 42.alb	1	0	Optimal	0.06	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	0.02	6	6.00	0.00
instance n=20 422.alb	1	0	Optimal	0.01	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	0.03	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	0.02	5	5.00	0.00
instance n=20 427.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=20 428.alb	1	0	Optimal	0.02	5	5.00	0.00
instance n=20 429.alb	1	0	Optimal	0.02	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	0.03	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	0.02	5	5.00	0.00
instance n=20 434.alb	1	0	Optimal	0.02	5	5.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 435.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=20 436.alb	1	0	Optimal	0.02	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	0.02	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	0.01	5	5.00	0.00
instance n=20 441.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 442.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 443.alb	1	0	Optimal	0.01	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	0.02	3	3.00	0.00
instance n=20 447.alb	1	0	Optimal	0.02	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	0.06	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	0.01	3	3.00	0.00
instance n=20 452.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 453.alb	1	0	Optimal	0.01	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	0.18	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	0.18	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	0.01	3	3.00	0.00
instance n=20 464.alb	1	0	Optimal	0.01	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	0.01	13	13.00	0.00
instance n=20 467.alb	1	0	Optimal	0.01	14	14.00	0.00
instance n=20 468.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 469.alb	1	0	Optimal	0.01	14	14.00	0.00
instance n=20 47.alb	1	0	Optimal	0.03	4	4.00	0.00
instance n=20 470.alb	1	0	Optimal	0.01	12	12.00	0.00
instance n=20 471.alb	1	0	Optimal	0.03	12	12.00	0.00
instance n=20 472.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=20 473.alb	1	0	Optimal	0.01	10	10.00	0.00
instance n=20 474.alb	1	0	Optimal	0.01	14	14.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 475.alb	1	0	Optimal	0.01	11	11.00	0.00
instance n=20 476.alb	1	0	Optimal	0.01	11	11.00	0.00
instance n=20 477.alb	1	0	Optimal	0.03	11	11.00	0.00
instance n=20 478.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 479.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 48.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 480.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 481.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=20 482.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 483.alb	1	0	Optimal	0.02	12	12.00	0.00
instance n=20 484.alb	1	0	Optimal	0.01	13	13.00	0.00
instance n=20 485.alb	1	0	Optimal	0.03	15	15.00	0.00
instance n=20 486.alb	1	0	Optimal	0.01	11	11.00	0.00
instance n=20 487.alb	1	0	Optimal	0.01	12	12.00	0.00
instance n=20 488.alb	1	0	Optimal	0.02	15	15.00	0.00
instance n=20 489.alb	1	0	Optimal	0.02	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	0.02	12	12.00	0.00
instance n=20 491.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 492.alb	1	0	Optimal	0.01	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	0.01	6	6.00	0.00
instance n=20 495.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 496.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 497.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 498.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 499.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 5.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 50.alb	1	0	Optimal	0.01	4	4.00	0.00
instance n=20 500.alb	1	0	Optimal	0.01	8	8.00	0.00
instance n=20 501.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 502.alb	1	0	Optimal	0.01	4	4.00	0.00
instance n=20 503.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 504.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 505.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 506.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 507.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 508.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 509.alb	1	0	Optimal	0.01	4	4.00	0.00
instance n=20 51.alb	1	0	Optimal	0.01	4	4.00	0.00
instance n=20 510.alb	1	0	Optimal	0.01	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	0.01	5	5.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 514.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 515.alb	1	0	Optimal	0.01	6	6.00	0.00
instance n=20 516.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 517.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 518.alb	1	0	Optimal	0.01	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	0.02	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	0.02	3	3.00	0.00
instance n=20 522.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 523.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 524.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 525.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 53.alb	1	0	Optimal	0.01	5	5.00	0.00
instance n=20 54.alb	1	0	Optimal	0.03	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	0.03	4	4.00	0.00
instance n=20 57.alb	1	0	Optimal	0.02	4	4.00	0.00
instance n=20 58.alb	1	0	Optimal	0.04	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	0.02	3	3.00	0.00
instance n=20 60.alb	1	0	Optimal	0.43	6	6.00	0.00
instance n=20 61.alb	1	0	Optimal	0.05	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	0.03	5	5.00	0.00
instance n=20 65.alb	1	0	Optimal	0.03	5	5.00	0.00
instance n=20 66.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 67.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 68.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 69.alb	1	0	Optimal	0.01	2	2.00	0.00
instance n=20 7.alb	1	0	Optimal	0.01	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	0.01	2	2.00	0.00
instance n=20 74.alb	1	0	Optimal	0.01	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	0.02	3	3.00	0.00
instance n=20 77.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 78.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 79.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 8.alb	1	0	Optimal	0.02	3	3.00	0.00
instance n=20 80.alb	1	0	Optimal	0.01	3	3.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=20 81.alb	1	0	Optimal	0.01	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	0.01	3	3.00	0.00
instance n=20 85.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 86.alb	1	0	Optimal	0.01	3	3.00	0.00
instance n=20 87.alb	1	0	Optimal	0.01	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	0.01	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
instance n=20 91.alb	1	0	Optimal	0.04	11	11.00	0.00
instance n=20 92.alb	1	0	Optimal	0.01	11	11.00	0.00
instance n=20 93.alb	1	0	Optimal	0.04	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	0.04	12	12.00	0.00
instance n=20 96.alb	1	0	Optimal	0.02	10	10.00	0.00
instance n=20 97.alb	1	0	Optimal	0.06	15	15.00	0.00
instance n=20 98.alb	1	0	Optimal	0.03	13	13.00	0.00
instance n=20 99.alb	1	0	Optimal	0.09	12	12.00	0.00
instance n=50 1.alb	1	0	Solution	30.04	8	4.00	50.00
instance n=50 10.alb	1	0	Solution	30.04	7	3.00	57.14
instance n=50 100.alb	1	0	Optimal	1.71	7	7.00	0.00
instance n=50 101.alb	1	0	Optimal	9.10	30	30.00	0.00
instance n=50 102.alb	1	0	Solution	30.04	32	26.00	18.75
instance n=50 103.alb	1	0	Optimal	0.11	29	29.00	0.00
instance n=50 104.alb	1	0	Optimal	0.98	27	27.00	0.00
instance n=50 105.alb	1	0	Optimal	13.85	24	24.00	0.00
instance n=50 106.alb	1	0	Optimal	7.87	28	28.00	0.00
instance n=50 107.alb	1	0	Optimal	1.00	28	28.00	0.00
instance n=50 108.alb	1	0	Optimal	0.21	30	30.00	0.00
instance n=50 109.alb	1	0	Optimal	0.10	30	30.00	0.00
instance n=50 11.alb	1	0	Solution	30.14	7	4.00	42.86
instance n=50 110.alb	1	0	Solution	30.04	26	20.00	23.08
instance n=50 111.alb	1	0	Optimal	0.35	28	28.00	0.00
instance n=50 112.alb	1	0	Optimal	0.98	27	27.00	0.00
instance n=50 113.alb	1	0	Optimal	6.56	28	28.00	0.00
instance n=50 114.alb	1	0	Optimal	1.61	27	27.00	0.00
instance n=50 115.alb	1	0	Solution	30.05	28	22.00	21.43
instance n=50 116.alb	1	0	Optimal	0.19	32	32.00	0.00
instance n=50 117.alb	1	0	Optimal	6.25	27	27.00	0.00
instance n=50 118.alb	1	0	Optimal	2.92	29	29.00	0.00
instance n=50 119.alb	1	0	Optimal	0.29	25	25.00	0.00
instance n=50 12.alb	1	0	Solution	30.03	6	3.00	50.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 120.alb	1	0	Optimal	2.95	27	27.00	0.00
instance n=50 121.alb	1	0	Optimal	4.17	32	32.00	0.00
instance n=50 122.alb	1	0	Optimal	19.27	29	29.00	0.00
instance n=50 123.alb	1	0	Optimal	0.22	32	32.00	0.00
instance n=50 124.alb	1	0	Optimal	17.88	29	29.00	0.00
instance n=50 125.alb	1	0	Optimal	0.09	33	33.00	0.00
instance n=50 126.alb	1	0	Optimal	5.08	12	12.00	0.00
instance n=50 127.alb	1	0	Optimal	3.64	14	14.00	0.00
instance n=50 128.alb	1	0	Optimal	1.09	12	12.00	0.00
instance n=50 129.alb	1	0	Optimal	5.41	13	13.00	0.00
instance n=50 13.alb	1	0	Solution	30.03	6	4.00	33.33
instance n=50 130.alb	1	0	Optimal	7.42	13	13.00	0.00
instance n=50 131.alb	1	0	Optimal	3.74	12	12.00	0.00
instance n=50 132.alb	1	0	Optimal	1.94	12	12.00	0.00
instance n=50 133.alb	1	0	Optimal	4.75	12	12.00	0.00
instance n=50 134.alb	1	0	Optimal	2.85	14	14.00	0.00
instance n=50 135.alb	1	0	Optimal	2.35	13	13.00	0.00
instance n=50 136.alb	1	0	Optimal	22.47	11	11.00	0.00
instance n=50 137.alb	1	0	Optimal	2.99	11	11.00	0.00
instance n=50 138.alb	1	0	Optimal	5.38	12	12.00	0.00
instance n=50 139.alb	1	0	Optimal	3.35	11	11.00	0.00
instance n=50 14.alb	1	0	Solution	30.02	7	3.00	57.14
instance n=50 140.alb	1	0	Optimal	2.40	12	12.00	0.00
instance n=50 141.alb	1	0	Optimal	1.21	13	13.00	0.00
instance n=50 142.alb	1	0	Optimal	8.76	11	11.00	0.00
instance n=50 143.alb	1	0	Optimal	0.67	12	12.00	0.00
instance n=50 144.alb	1	0	Optimal	0.67	13	13.00	0.00
instance n=50 145.alb	1	0	Optimal	1.38	10	10.00	0.00
instance n=50 146.alb	1	0	Optimal	1.16	13	13.00	0.00
instance n=50 147.alb	1	0	Optimal	10.53	13	13.00	0.00
instance n=50 148.alb	1	0	Optimal	3.31	10	10.00	0.00
instance n=50 149.alb	1	0	Optimal	1.29	12	12.00	0.00
instance n=50 15.alb	1	0	Solution	30.03	8	4.00	50.00
instance n=50 150.alb	1	0	Optimal	1.12	11	11.00	0.00
instance n=50 151.alb	1	0	Solution	30.04	7	4.00	42.86
instance n=50 152.alb	1	0	Solution	30.03	7	3.00	57.14
instance n=50 153.alb	1	0	Solution	30.03	7	4.00	42.86
instance n=50 154.alb	1	0	Solution	30.03	8	4.00	50.00
instance n=50 155.alb	1	0	Solution	30.12	7	3.00	57.14
instance n=50 156.alb	1	0	Solution	30.02	7	4.00	42.86
instance n=50 157.alb	1	0	Solution	30.04	8	5.00	37.50
instance n=50 158.alb	1	0	Solution	30.01	7	3.00	57.14
instance n=50 159.alb	1	0	Solution	30.04	7	3.00	57.14
instance n=50 16.alb	1	0	Solution	30.02	8	4.00	50.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 160.alb	1	0	Solution	30.03	8	4.00	50.00
instance n=50 161.alb	1	0	Solution	30.02	7	4.00	42.86
instance n=50 162.alb	1	0	Solution	30.04	8	4.00	50.00
instance n=50 163.alb	1	0	Solution	30.03	7	3.00	57.14
instance n=50 164.alb	1	0	Solution	30.07	7	5.00	28.57
instance n=50 165.alb	1	0	Solution	30.03	8	3.00	62.50
instance n=50 166.alb	1	0	Solution	30.05	8	4.00	50.00
instance n=50 167.alb	1	0	Solution	30.04	7	4.00	42.86
instance n=50 168.alb	1	0	Solution	30.03	8	3.00	62.50
instance n=50 169.alb	1	0	Solution	30.02	8	4.00	50.00
instance n=50 17.alb	1	0	Solution	30.12	7	4.00	42.86
instance n=50 170.alb	1	0	Solution	30.02	7	4.00	42.86
instance n=50 171.alb	1	0	Solution	30.04	8	4.00	50.00
instance n=50 172.alb	1	0	Solution	30.03	7	4.00	42.86
instance n=50 173.alb	1	0	Solution	30.04	7	3.00	57.14
instance n=50 174.alb	1	0	Solution	30.01	7	4.00	42.86
instance n=50 175.alb	1	0	Solution	30.03	7	4.00	42.86
instance n=50 176.alb	1	0	Solution	30.06	27	9.00	66.67
instance n=50 177.alb	1	0	Solution	30.04	28	11.00	60.71
instance n=50 178.alb	1	0	Solution	30.06	28	11.00	60.71
instance n=50 179.alb	1	0	Solution	30.05	26	14.00	46.15
instance n=50 18.alb	1	0	Solution	30.07	7	4.00	42.86
instance n=50 180.alb	1	0	Solution	30.05	26	10.00	61.54
instance n=50 181.alb	1	0	Optimal	27.87	29	29.00	0.00
instance n=50 182.alb	1	0	Solution	30.05	26	10.00	61.54
instance n=50 183.alb	1	0	Solution	30.05	28	18.00	35.71
instance n=50 184.alb	1	0	Optimal	0.03	38	38.00	0.00
instance n=50 185.alb	1	0	Optimal	3.31	26	26.00	0.00
instance n=50 186.alb	1	0	Optimal	13.12	26	26.00	0.00
instance n=50 187.alb	1	0	Solution	30.06	26	14.00	46.15
instance n=50 188.alb	1	0	Solution	30.04	25	11.00	56.00
instance n=50 189.alb	1	0	Solution	30.06	26	10.00	61.54
instance n=50 19.alb	1	0	Solution	30.04	8	4.00	50.00
instance n=50 190.alb	1	0	Optimal	0.20	30	30.00	0.00
instance n=50 191.alb	1	0	Solution	30.05	28	13.00	53.57
instance n=50 192.alb	1	0	Solution	30.05	27	16.00	40.74
instance n=50 193.alb	1	0	Solution	30.07	29	15.00	48.28
instance n=50 194.alb	1	0	Solution	30.06	28	11.00	60.71
instance n=50 195.alb	1	0	Solution	30.06	28	10.00	64.29
instance n=50 196.alb	1	0	Solution	30.05	27	12.00	55.56
instance n=50 197.alb	1	0	Solution	30.15	28	10.00	64.29
instance n=50 198.alb	1	0	Optimal	0.04	28	28.00	0.00
instance n=50 199.alb	1	0	Optimal	0.27	29	29.00	0.00
instance n=50 2.alb	1	0	Solution	30.03	6	3.00	50.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 20.alb	1	0	Solution	30.02	8	4.00	50.00
instance n=50 200.alb	1	0	Solution	30.05	25	11.00	56.00
instance n=50 201.alb	1	0	Solution	30.05	13	6.00	53.85
instance n=50 202.alb	1	0	Solution	30.04	9	5.00	44.44
instance n=50 203.alb	1	0	Solution	30.02	11	5.00	54.55
instance n=50 204.alb	1	0	Solution	30.03	10	4.00	60.00
instance n=50 205.alb	1	0	Solution	30.05	13	6.00	53.85
instance n=50 206.alb	1	0	Solution	30.07	11	5.00	54.55
instance n=50 207.alb	1	0	Solution	30.03	10	5.00	50.00
instance n=50 208.alb	1	0	Solution	30.06	13	7.00	46.15
instance n=50 209.alb	1	0	Solution	30.04	11	5.00	54.55
instance n=50 21.alb	1	0	Solution	30.03	6	4.00	33.33
instance n=50 210.alb	1	0	Solution	30.04	13	6.00	53.85
instance n=50 211.alb	1	0	Solution	30.05	12	5.00	58.33
instance n=50 212.alb	1	0	Solution	30.09	10	5.00	50.00
instance n=50 213.alb	1	0	Solution	30.05	13	6.00	53.85
instance n=50 214.alb	1	0	Solution	30.04	11	5.00	54.55
instance n=50 215.alb	1	0	Solution	30.03	11	6.00	45.45
instance n=50 216.alb	1	0	Solution	30.17	12	5.00	58.33
instance n=50 217.alb	1	0	Solution	30.03	13	6.00	53.85
instance n=50 218.alb	1	0	Solution	30.04	12	5.00	58.33
instance n=50 219.alb	1	0	Solution	30.03	11	4.00	63.64
instance n=50 22.alb	1	0	Solution	30.04	7	4.00	42.86
instance n=50 220.alb	1	0	Solution	30.92	11	6.00	45.45
instance n=50 221.alb	1	0	Solution	30.62	11	4.00	63.64
instance n=50 222.alb	1	0	Solution	30.05	14	7.00	50.00
instance n=50 223.alb	1	0	Solution	30.05	11	4.00	63.64
instance n=50 224.alb	1	0	Solution	30.03	11	5.00	54.55
instance n=50 225.alb	1	0	Solution	30.05	12	7.00	41.67
instance n=50 226.alb	1	0	Optimal	0.36	7	7.00	0.00
instance n=50 227.alb	1	0	Optimal	0.25	6	6.00	0.00
instance n=50 228.alb	1	0	Optimal	0.14	6	6.00	0.00
instance n=50 229.alb	1	0	Optimal	0.10	6	6.00	0.00
instance n=50 23.alb	1	0	Solution	30.10	7	5.00	28.57
instance n=50 230.alb	1	0	Optimal	1.09	7	7.00	0.00
instance n=50 231.alb	1	0	Optimal	0.17	7	7.00	0.00
instance n=50 232.alb	1	0	Optimal	0.20	7	7.00	0.00
instance n=50 233.alb	1	0	Optimal	0.08	6	6.00	0.00
instance n=50 234.alb	1	0	Optimal	1.55	8	8.00	0.00
instance n=50 235.alb	1	0	Optimal	0.46	7	7.00	0.00
instance n=50 236.alb	1	0	Optimal	0.20	7	7.00	0.00
instance n=50 237.alb	1	0	Optimal	0.36	8	8.00	0.00
instance n=50 238.alb	1	0	Optimal	1.50	7	7.00	0.00
instance n=50 239.alb	1	0	Optimal	0.31	7	7.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 24.alb	1	0	Solution	30.03	7	3.00	57.14
instance n=50 240.alb	1	0	Optimal	0.74	7	7.00	0.00
instance n=50 241.alb	1	0	Optimal	0.70	7	7.00	0.00
instance n=50 242.alb	1	0	Optimal	0.30	8	8.00	0.00
instance n=50 243.alb	1	0	Optimal	1.15	7	7.00	0.00
instance n=50 244.alb	1	0	Optimal	0.08	7	7.00	0.00
instance n=50 245.alb	1	0	Optimal	0.24	7	7.00	0.00
instance n=50 246.alb	1	0	Optimal	1.44	8	8.00	0.00
instance n=50 247.alb	1	0	Optimal	0.35	7	7.00	0.00
instance n=50 248.alb	1	0	Optimal	0.23	7	7.00	0.00
instance n=50 249.alb	1	0	Optimal	0.28	7	7.00	0.00
instance n=50 25.alb	1	0	Solution	30.03	6	3.00	50.00
instance n=50 250.alb	1	0	Optimal	0.26	7	7.00	0.00
instance n=50 251.alb	1	0	Optimal	1.74	27	27.00	0.00
instance n=50 252.alb	1	0	Optimal	2.13	32	32.00	0.00
instance n=50 253.alb	1	0	Optimal	2.97	28	28.00	0.00
instance n=50 254.alb	1	0	Optimal	0.06	30	30.00	0.00
instance n=50 255.alb	1	0	Optimal	0.64	29	29.00	0.00
instance n=50 256.alb	1	0	Optimal	12.37	30	30.00	0.00
instance n=50 257.alb	1	0	Optimal	2.06	33	33.00	0.00
instance n=50 258.alb	1	0	Optimal	2.46	28	28.00	0.00
instance n=50 259.alb	1	0	Optimal	2.32	31	31.00	0.00
instance n=50 26.alb	1	0	Solution	30.04	27	11.00	59.26
instance n=50 260.alb	1	0	Optimal	0.19	29	29.00	0.00
instance n=50 261.alb	1	0	Optimal	1.91	28	28.00	0.00
instance n=50 262.alb	1	0	Optimal	0.50	31	31.00	0.00
instance n=50 263.alb	1	0	Optimal	0.33	29	29.00	0.00
instance n=50 264.alb	1	0	Optimal	1.68	27	27.00	0.00
instance n=50 265.alb	1	0	Optimal	0.45	27	27.00	0.00
instance n=50 266.alb	1	0	Optimal	2.37	29	29.00	0.00
instance n=50 267.alb	1	0	Optimal	2.02	28	28.00	0.00
instance n=50 268.alb	1	0	Optimal	2.60	29	29.00	0.00
instance n=50 269.alb	1	0	Optimal	6.15	26	26.00	0.00
instance n=50 27.alb	1	0	Solution	30.07	30	12.00	60.00
instance n=50 270.alb	1	0	Optimal	2.84	28	28.00	0.00
instance n=50 271.alb	1	0	Optimal	2.35	31	31.00	0.00
instance n=50 272.alb	1	0	Optimal	1.16	27	27.00	0.00
instance n=50 273.alb	1	0	Optimal	3.36	27	27.00	0.00
instance n=50 274.alb	1	0	Optimal	0.11	29	29.00	0.00
instance n=50 275.alb	1	0	Optimal	2.90	27	27.00	0.00
instance n=50 276.alb	1	0	Optimal	0.34	12	12.00	0.00
instance n=50 277.alb	1	0	Optimal	0.31	13	13.00	0.00
instance n=50 278.alb	1	0	Optimal	0.55	12	12.00	0.00
instance n=50 279.alb	1	0	Optimal	0.83	11	11.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 28.alb	1	0	Solution	30.06	28	11.00	60.71
instance n=50 280.alb	1	0	Optimal	0.50	13	13.00	0.00
instance n=50 281.alb	1	0	Optimal	0.29	11	11.00	0.00
instance n=50 282.alb	1	0	Optimal	2.45	12	12.00	0.00
instance n=50 283.alb	1	0	Optimal	1.12	12	12.00	0.00
instance n=50 284.alb	1	0	Optimal	1.24	11	11.00	0.00
instance n=50 285.alb	1	0	Optimal	0.54	13	13.00	0.00
instance n=50 286.alb	1	0	Optimal	0.44	11	11.00	0.00
instance n=50 287.alb	1	0	Optimal	1.17	12	12.00	0.00
instance n=50 288.alb	1	0	Optimal	0.26	10	10.00	0.00
instance n=50 289.alb	1	0	Optimal	1.14	11	11.00	0.00
instance n=50 29.alb	1	0	Optimal	0.03	29	29.00	0.00
instance n=50 290.alb	1	0	Optimal	1.76	14	14.00	0.00
instance n=50 291.alb	1	0	Optimal	0.49	12	12.00	0.00
instance n=50 292.alb	1	0	Optimal	0.93	13	13.00	0.00
instance n=50 293.alb	1	0	Optimal	0.65	12	12.00	0.00
instance n=50 294.alb	1	0	Optimal	0.49	13	13.00	0.00
instance n=50 295.alb	1	0	Optimal	2.05	16	16.00	0.00
instance n=50 296.alb	1	0	Optimal	16.22	13	13.00	0.00
instance n=50 297.alb	1	0	Optimal	1.63	13	13.00	0.00
instance n=50 298.alb	1	0	Optimal	1.25	11	11.00	0.00
instance n=50 299.alb	1	0	Optimal	0.87	12	12.00	0.00
instance n=50 3.alb	1	0	Solution	30.04	8	4.00	50.00
instance n=50 30.alb	1	0	Solution	30.07	26	11.00	57.69
instance n=50 300.alb	1	0	Optimal	0.56	12	12.00	0.00
instance n=50 301.alb	1	0	Solution	30.03	6	3.00	50.00
instance n=50 302.alb	1	0	Solution	30.07	7	3.00	57.14
instance n=50 303.alb	1	0	Solution	30.07	8	3.00	62.50
instance n=50 304.alb	1	0	Solution	30.05	7	4.00	42.86
instance n=50 305.alb	1	0	Solution	30.03	8	4.00	50.00
instance n=50 306.alb	1	0	Solution	30.04	7	3.00	57.14
instance n=50 307.alb	1	0	Solution	30.06	7	3.00	57.14
instance n=50 308.alb	1	0	Solution	30.09	8	4.00	50.00
instance n=50 309.alb	1	0	Solution	30.02	7	4.00	42.86
instance n=50 31.alb	1	0	Solution	30.06	28	9.00	67.86
instance n=50 310.alb	1	0	Solution	30.03	8	4.00	50.00
instance n=50 311.alb	1	0	Solution	30.04	8	4.00	50.00
instance n=50 312.alb	1	0	Solution	30.02	6	4.00	33.33
instance n=50 313.alb	1	0	Solution	30.03	8	3.00	62.50
instance n=50 314.alb	1	0	Solution	30.03	7	3.00	57.14
instance n=50 315.alb	1	0	Solution	30.04	8	3.00	62.50
instance n=50 316.alb	1	0	Solution	30.09	8	4.00	50.00
instance n=50 317.alb	1	0	Solution	30.04	6	4.00	33.33
instance n=50 318.alb	1	0	Solution	30.05	8	4.00	50.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 319.alb	1	0	Solution	30.04	7	3.00	57.14
instance n=50 32.alb	1	0	Solution	30.04	25	11.00	56.00
instance n=50 320.alb	1	0	Solution	30.03	8	4.00	50.00
instance n=50 321.alb	1	0	Solution	30.03	6	3.00	50.00
instance n=50 322.alb	1	0	Solution	30.06	7	3.00	57.14
instance n=50 323.alb	1	0	Solution	30.03	7	4.00	42.86
instance n=50 324.alb	1	0	Solution	30.03	7	3.00	57.14
instance n=50 325.alb	1	0	Solution	30.03	7	4.00	42.86
instance n=50 326.alb	1	0	Optimal	3.40	33	33.00	0.00
instance n=50 327.alb	1	0	Optimal	0.07	28	28.00	0.00
instance n=50 328.alb	1	0	Optimal	0.05	32	32.00	0.00
instance n=50 329.alb	1	0	Solution	30.05	25	9.00	64.00
instance n=50 33.alb	1	0	Solution	30.06	25	10.00	60.00
instance n=50 330.alb	1	0	Optimal	0.04	29	29.00	0.00
instance n=50 331.alb	1	0	Solution	30.83	29	12.00	58.62
instance n=50 332.alb	1	0	Solution	30.04	25	11.00	56.00
instance n=50 333.alb	1	0	Solution	30.06	28	11.00	60.71
instance n=50 334.alb	1	0	Optimal	0.03	29	29.00	0.00
instance n=50 335.alb	1	0	Solution	30.08	27	17.00	37.04
instance n=50 336.alb	1	0	Solution	30.03	26	10.00	61.54
instance n=50 337.alb	1	0	Solution	30.05	26	11.00	57.69
instance n=50 338.alb	1	0	Optimal	0.57	26	26.00	0.00
instance n=50 339.alb	1	0	Solution	30.06	27	11.00	59.26
instance n=50 34.alb	1	0	Solution	30.03	30	13.00	56.67
instance n=50 340.alb	1	0	Solution	30.06	28	11.00	60.71
instance n=50 341.alb	1	0	Solution	30.05	27	10.00	62.96
instance n=50 342.alb	1	0	Solution	30.14	28	13.00	53.57
instance n=50 343.alb	1	0	Solution	30.05	27	10.00	62.96
instance n=50 344.alb	1	0	Solution	30.06	30	11.00	63.33
instance n=50 345.alb	1	0	Solution	30.05	29	10.00	65.52
instance n=50 346.alb	1	0	Solution	30.06	27	10.00	62.96
instance n=50 347.alb	1	0	Optimal	5.88	25	25.00	0.00
instance n=50 348.alb	1	0	Optimal	0.03	30	30.00	0.00
instance n=50 349.alb	1	0	Solution	30.99	28	11.00	60.71
instance n=50 35.alb	1	0	Optimal	2.86	31	31.00	0.00
instance n=50 350.alb	1	0	Solution	31.00	24	8.00	66.67
instance n=50 351.alb	1	0	Solution	30.13	12	7.00	41.67
instance n=50 352.alb	1	0	Solution	30.02	10	5.00	50.00
instance n=50 353.alb	1	0	Solution	30.13	13	4.00	69.23
instance n=50 354.alb	1	0	Solution	30.56	14	6.00	57.14
instance n=50 355.alb	1	0	Solution	30.04	11	4.00	63.64
instance n=50 356.alb	1	0	Solution	30.03	15	6.00	60.00
instance n=50 357.alb	1	0	Solution	30.05	12	5.00	58.33
instance n=50 358.alb	1	0	Solution	30.04	11	5.00	54.55

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 359.alb	1	0	Solution	30.04	10	5.00	50.00
instance n=50 36.alb	1	0	Solution	30.06	31	14.00	54.84
instance n=50 360.alb	1	0	Solution	30.02	12	5.00	58.33
instance n=50 361.alb	1	0	Solution	30.04	11	4.00	63.64
instance n=50 362.alb	1	0	Solution	30.08	10	5.00	50.00
instance n=50 363.alb	1	0	Solution	30.04	12	5.00	58.33
instance n=50 364.alb	1	0	Solution	30.04	13	6.00	53.85
instance n=50 365.alb	1	0	Solution	30.04	11	4.00	63.64
instance n=50 366.alb	1	0	Solution	30.04	13	5.00	61.54
instance n=50 367.alb	1	0	Solution	30.05	12	5.00	58.33
instance n=50 368.alb	1	0	Solution	30.05	12	4.00	66.67
instance n=50 369.alb	1	0	Solution	30.04	12	7.00	41.67
instance n=50 37.alb	1	0	Solution	30.06	32	11.00	65.63
instance n=50 370.alb	1	0	Solution	30.04	12	5.00	58.33
instance n=50 371.alb	1	0	Solution	30.04	11	4.00	63.64
instance n=50 372.alb	1	0	Solution	30.03	10	4.00	60.00
instance n=50 373.alb	1	0	Solution	30.40	12	6.00	50.00
instance n=50 374.alb	1	0	Solution	30.13	11	6.00	45.45
instance n=50 375.alb	1	0	Solution	30.21	13	6.00	53.85
instance n=50 376.alb	1	0	Optimal	0.65	7	7.00	0.00
instance n=50 377.alb	1	0	Optimal	0.18	7	7.00	0.00
instance n=50 378.alb	1	0	Optimal	1.05	8	8.00	0.00
instance n=50 379.alb	1	0	Optimal	1.73	7	7.00	0.00
instance n=50 38.alb	1	0	Solution	30.05	31	13.00	58.06
instance n=50 380.alb	1	0	Optimal	0.66	7	7.00	0.00
instance n=50 381.alb	1	0	Optimal	0.60	8	8.00	0.00
instance n=50 382.alb	1	0	Optimal	0.47	6	6.00	0.00
instance n=50 383.alb	1	0	Optimal	6.91	7	7.00	0.00
instance n=50 384.alb	1	0	Optimal	0.73	8	8.00	0.00
instance n=50 385.alb	1	0	Optimal	0.53	7	7.00	0.00
instance n=50 386.alb	1	0	Optimal	1.03	7	7.00	0.00
instance n=50 387.alb	1	0	Optimal	3.17	8	8.00	0.00
instance n=50 388.alb	1	0	Optimal	0.55	7	7.00	0.00
instance n=50 389.alb	1	0	Optimal	0.51	8	8.00	0.00
instance n=50 39.alb	1	0	Solution	30.05	29	12.00	58.62
instance n=50 390.alb	1	0	Optimal	0.61	7	7.00	0.00
instance n=50 391.alb	1	0	Optimal	0.19	7	7.00	0.00
instance n=50 392.alb	1	0	Optimal	4.44	8	8.00	0.00
instance n=50 393.alb	1	0	Optimal	0.63	7	7.00	0.00
instance n=50 394.alb	1	0	Optimal	1.45	8	8.00	0.00
instance n=50 395.alb	1	0	Optimal	1.41	7	7.00	0.00
instance n=50 396.alb	1	0	Optimal	5.34	8	8.00	0.00
instance n=50 397.alb	1	0	Optimal	0.42	7	7.00	0.00
instance n=50 398.alb	1	0	Optimal	0.14	6	6.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 399.alb	1	0	Optimal	1.40	7	7.00	0.00
instance n=50 4.alb	1	0	Solution	30.01	7	4.00	42.86
instance n=50 40.alb	1	0	Solution	30.05	26	10.00	61.54
instance n=50 400.alb	1	0	Optimal	1.42	8	8.00	0.00
instance n=50 401.alb	1	0	Solution	30.06	28	20.00	28.57
instance n=50 402.alb	1	0	Optimal	7.40	27	27.00	0.00
instance n=50 403.alb	1	0	Optimal	1.84	34	34.00	0.00
instance n=50 404.alb	1	0	Optimal	2.24	31	31.00	0.00
instance n=50 405.alb	1	0	Optimal	1.20	27	27.00	0.00
instance n=50 406.alb	1	0	Optimal	2.02	32	32.00	0.00
instance n=50 407.alb	1	0	Optimal	4.66	29	29.00	0.00
instance n=50 408.alb	1	0	Optimal	22.30	26	26.00	0.00
instance n=50 409.alb	1	0	Optimal	5.38	33	33.00	0.00
instance n=50 41.alb	1	0	Optimal	2.83	25	25.00	0.00
instance n=50 410.alb	1	0	Optimal	0.19	28	28.00	0.00
instance n=50 411.alb	1	0	Optimal	0.18	29	29.00	0.00
instance n=50 412.alb	1	0	Optimal	0.08	26	26.00	0.00
instance n=50 413.alb	1	0	Optimal	0.16	30	30.00	0.00
instance n=50 414.alb	1	0	Optimal	17.88	27	27.00	0.00
instance n=50 415.alb	1	0	Optimal	0.34	28	28.00	0.00
instance n=50 416.alb	1	0	Optimal	0.39	27	27.00	0.00
instance n=50 417.alb	1	0	Solution	30.05	30	22.00	26.67
instance n=50 418.alb	1	0	Optimal	0.92	27	27.00	0.00
instance n=50 419.alb	1	0	Optimal	7.67	33	33.00	0.00
instance n=50 42.alb	1	0	Solution	30.05	24	9.00	62.50
instance n=50 420.alb	1	0	Optimal	9.05	28	28.00	0.00
instance n=50 421.alb	1	0	Optimal	2.25	34	34.00	0.00
instance n=50 422.alb	1	0	Optimal	1.85	29	29.00	0.00
instance n=50 423.alb	1	0	Optimal	0.21	29	29.00	0.00
instance n=50 424.alb	1	0	Optimal	1.24	27	27.00	0.00
instance n=50 425.alb	1	0	Optimal	11.88	34	34.00	0.00
instance n=50 426.alb	1	0	Optimal	1.96	11	11.00	0.00
instance n=50 427.alb	1	0	Optimal	1.61	12	12.00	0.00
instance n=50 428.alb	1	0	Optimal	4.53	13	13.00	0.00
instance n=50 429.alb	1	0	Optimal	0.89	11	11.00	0.00
instance n=50 43.alb	1	0	Solution	30.04	25	11.00	56.00
instance n=50 430.alb	1	0	Optimal	1.62	14	14.00	0.00
instance n=50 431.alb	1	0	Optimal	2.07	11	11.00	0.00
instance n=50 432.alb	1	0	Optimal	0.95	12	12.00	0.00
instance n=50 433.alb	1	0	Optimal	21.40	12	12.00	0.00
instance n=50 434.alb	1	0	Optimal	0.80	11	11.00	0.00
instance n=50 435.alb	1	0	Optimal	1.75	11	11.00	0.00
instance n=50 436.alb	1	0	Solution	30.04	11	8.00	27.27
instance n=50 437.alb	1	0	Optimal	2.97	12	12.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 438.alb	1	0	Optimal	1.22	10	10.00	0.00
instance n=50 439.alb	1	0	Optimal	1.19	12	12.00	0.00
instance n=50 44.alb	1	0	Solution	30.03	25	11.00	56.00
instance n=50 440.alb	1	0	Optimal	2.56	13	13.00	0.00
instance n=50 441.alb	1	0	Optimal	16.57	11	11.00	0.00
instance n=50 442.alb	1	0	Optimal	0.75	12	12.00	0.00
instance n=50 443.alb	1	0	Optimal	0.47	11	11.00	0.00
instance n=50 444.alb	1	0	Optimal	0.94	12	12.00	0.00
instance n=50 445.alb	1	0	Optimal	1.89	12	12.00	0.00
instance n=50 446.alb	1	0	Optimal	0.55	12	12.00	0.00
instance n=50 447.alb	1	0	Optimal	1.83	13	13.00	0.00
instance n=50 448.alb	1	0	Optimal	0.48	12	12.00	0.00
instance n=50 449.alb	1	0	Optimal	0.53	11	11.00	0.00
instance n=50 45.alb	1	0	Solution	30.04	25	10.00	60.00
instance n=50 450.alb	1	0	Optimal	0.68	11	11.00	0.00
instance n=50 451.alb	1	0	Optimal	0.03	8	8.00	0.00
instance n=50 452.alb	1	0	Optimal	0.02	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	0.03	8	8.00	0.00
instance n=50 455.alb	1	0	Optimal	0.02	6	6.00	0.00
instance n=50 456.alb	1	0	Optimal	0.02	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	0.03	7	7.00	0.00
instance n=50 459.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 46.alb	1	0	Optimal	0.12	28	28.00	0.00
instance n=50 460.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 461.alb	1	0	Optimal	0.04	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	0.04	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	0.03	8	8.00	0.00
instance n=50 466.alb	1	0	Optimal	0.03	7	7.00	0.00
instance n=50 467.alb	1	0	Optimal	0.04	9	9.00	0.00
instance n=50 468.alb	1	0	Optimal	0.02	7	7.00	0.00
instance n=50 469.alb	1	0	Optimal	0.04	8	8.00	0.00
instance n=50 47.alb	1	0	Optimal	0.10	28	28.00	0.00
instance n=50 470.alb	1	0	Optimal	0.04	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	0.04	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	0.02	7	7.00	0.00
instance n=50 475.alb	1	0	Optimal	0.04	6	6.00	0.00
instance n=50 476.alb	1	0	Optimal	0.09	28	28.00	0.00
instance n=50 477.alb	1	0	Optimal	0.08	29	29.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 478.alb	1	0	Optimal	0.10	32	32.00	0.00
instance n=50 479.alb	1	0	Optimal	0.05	28	28.00	0.00
instance n=50 48.alb	1	0	Solution	30.05	27	12.00	55.56
instance n=50 480.alb	1	0	Optimal	0.04	34	34.00	0.00
instance n=50 481.alb	1	0	Optimal	0.08	28	28.00	0.00
instance n=50 482.alb	1	0	Optimal	0.07	27	27.00	0.00
instance n=50 483.alb	1	0	Optimal	0.09	30	30.00	0.00
instance n=50 484.alb	1	0	Optimal	0.05	32	32.00	0.00
instance n=50 485.alb	1	0	Optimal	0.10	31	31.00	0.00
instance n=50 486.alb	1	0	Optimal	0.06	32	32.00	0.00
instance n=50 487.alb	1	0	Optimal	0.11	31	31.00	0.00
instance n=50 488.alb	1	0	Optimal	0.03	31	31.00	0.00
instance n=50 489.alb	1	0	Optimal	0.03	35	35.00	0.00
instance n=50 49.alb	1	0	Solution	30.06	25	11.00	56.00
instance n=50 490.alb	1	0	Optimal	0.05	29	29.00	0.00
instance n=50 491.alb	1	0	Optimal	0.08	35	35.00	0.00
instance n=50 492.alb	1	0	Optimal	0.05	29	29.00	0.00
instance n=50 493.alb	1	0	Optimal	0.08	30	30.00	0.00
instance n=50 494.alb	1	0	Optimal	0.05	32	32.00	0.00
instance n=50 495.alb	1	0	Optimal	0.08	34	34.00	0.00
instance n=50 496.alb	1	0	Optimal	0.08	29	29.00	0.00
instance n=50 497.alb	1	0	Optimal	0.09	30	30.00	0.00
instance n=50 498.alb	1	0	Optimal	0.06	30	30.00	0.00
instance n=50 499.alb	1	0	Optimal	0.10	33	33.00	0.00
instance n=50 5.alb	1	0	Solution	30.02	7	4.00	42.86
instance n=50 50.alb	1	0	Solution	30.06	27	11.00	59.26
instance n=50 500.alb	1	0	Optimal	0.07	34	34.00	0.00
instance n=50 501.alb	1	0	Optimal	0.05	12	12.00	0.00
instance n=50 502.alb	1	0	Optimal	0.05	10	10.00	0.00
instance n=50 503.alb	1	0	Optimal	0.05	13	13.00	0.00
instance n=50 504.alb	1	0	Optimal	0.06	11	11.00	0.00
instance n=50 505.alb	1	0	Optimal	0.05	12	12.00	0.00
instance n=50 506.alb	1	0	Optimal	0.07	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	0.04	14	14.00	0.00
instance n=50 509.alb	1	0	Optimal	0.04	13	13.00	0.00
instance n=50 51.alb	1	0	Solution	30.73	12	5.00	58.33
instance n=50 510.alb	1	0	Optimal	0.04	11	11.00	0.00
instance n=50 511.alb	1	0	Optimal	0.05	13	13.00	0.00
instance n=50 512.alb	1	0	Optimal	0.04	13	13.00	0.00
instance n=50 513.alb	1	0	Optimal	0.18	12	12.00	0.00
instance n=50 514.alb	1	0	Optimal	0.04	12	12.00	0.00
instance n=50 515.alb	1	0	Optimal	0.04	11	11.00	0.00
instance n=50 516.alb	1	0	Optimal	0.05	13	13.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 517.alb	1	0	Optimal	0.06	14	14.00	0.00
instance n=50 518.alb	1	0	Optimal	0.05	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	Solution	30.03	11	5.00	54.55
instance n=50 520.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 521.alb	1	0	Optimal	0.05	10	10.00	0.00
instance n=50 522.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 523.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 524.alb	1	0	Optimal	0.05	14	14.00	0.00
instance n=50 525.alb	1	0	Optimal	0.05	11	11.00	0.00
instance n=50 53.alb	1	0	Solution	30.36	13	6.00	53.85
instance n=50 54.alb	1	0	Solution	30.03	11	4.00	63.64
instance n=50 55.alb	1	0	Solution	30.04	13	6.00	53.85
instance n=50 56.alb	1	0	Solution	30.04	11	5.00	54.55
instance n=50 57.alb	1	0	Solution	30.05	13	5.00	61.54
instance n=50 58.alb	1	0	Solution	30.03	11	5.00	54.55
instance n=50 59.alb	1	0	Solution	30.64	11	4.00	63.64
instance n=50 6.alb	1	0	Solution	30.02	6	3.00	50.00
instance n=50 60.alb	1	0	Solution	30.04	12	7.00	41.67
instance n=50 61.alb	1	0	Solution	30.04	13	6.00	53.85
instance n=50 62.alb	1	0	Solution	30.04	13	7.00	46.15
instance n=50 63.alb	1	0	Solution	30.15	12	5.00	58.33
instance n=50 64.alb	1	0	Solution	30.04	13	5.00	61.54
instance n=50 65.alb	1	0	Solution	30.04	12	5.00	58.33
instance n=50 66.alb	1	0	Solution	30.03	12	5.00	58.33
instance n=50 67.alb	1	0	Solution	30.03	12	7.00	41.67
instance n=50 68.alb	1	0	Solution	30.04	12	5.00	58.33
instance n=50 69.alb	1	0	Solution	30.02	12	7.00	41.67
instance n=50 7.alb	1	0	Solution	30.21	7	4.00	42.86
instance n=50 70.alb	1	0	Solution	30.03	10	5.00	50.00
instance n=50 71.alb	1	0	Solution	30.05	13	6.00	53.85
instance n=50 72.alb	1	0	Solution	30.03	11	5.00	54.55
instance n=50 73.alb	1	0	Solution	30.05	11	5.00	54.55
instance n=50 74.alb	1	0	Solution	30.04	12	5.00	58.33
instance n=50 75.alb	1	0	Solution	30.04	11	6.00	45.45
instance n=50 76.alb	1	0	Optimal	1.83	7	7.00	0.00
instance n=50 77.alb	1	0	Optimal	1.47	7	7.00	0.00
instance n=50 78.alb	1	0	Optimal	10.66	7	7.00	0.00
instance n=50 79.alb	1	0	Optimal	2.77	8	8.00	0.00
instance n=50 8.alb	1	0	Solution	30.02	7	4.00	42.86
instance n=50 80.alb	1	0	Optimal	1.11	7	7.00	0.00
instance n=50 81.alb	1	0	Optimal	0.89	7	7.00	0.00
instance n=50 82.alb	1	0	Optimal	0.17	6	6.00	0.00
instance n=50 83.alb	1	0	Optimal	2.88	8	8.00	0.00

Table 6.2: Results for SALBP-1 Problems (CPSat) (1050 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance n=50 84.alb	1	0	Optimal	0.69	7	7.00	0.00
instance n=50 85.alb	1	0	Optimal	13.21	8	8.00	0.00
instance n=50 86.alb	1	0	Optimal	1.84	7	7.00	0.00
instance n=50 87.alb	1	0	Optimal	4.03	8	8.00	0.00
instance n=50 88.alb	1	0	Solution	30.23	8	6.00	25.00
instance n=50 89.alb	1	0	Optimal	1.25	7	7.00	0.00
instance n=50 9.alb	1	0	Solution	30.07	9	4.00	55.56
instance n=50 90.alb	1	0	Optimal	0.61	7	7.00	0.00
instance n=50 91.alb	1	0	Optimal	1.05	7	7.00	0.00
instance n=50 92.alb	1	0	Optimal	0.55	7	7.00	0.00
instance n=50 93.alb	1	0	Optimal	2.49	7	7.00	0.00
instance n=50 94.alb	1	0	Optimal	1.31	7	7.00	0.00
instance n=50 95.alb	1	0	Optimal	1.73	7	7.00	0.00
instance n=50 96.alb	1	0	Optimal	1.32	7	7.00	0.00
instance n=50 97.alb	1	0	Optimal	0.20	7	7.00	0.00
instance n=50 98.alb	1	0	Optimal	9.55	8	8.00	0.00
instance n=50 99.alb	1	0	Optimal	3.58	7	7.00	0.00

Chapter 7

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.

7.1 Results for CPOptimizer

Table 7.1: Results for Test Scheduling Problems (CPO) (840 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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
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
t500m100r10-1.pl.json	500	100	Solution	30.96	50084	799.00	98.40
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
t500m100r10-12.pl.json	500	100	Solution	30.64	52619	801.00	98.48
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

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
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
t500m100r3-17.pl.json	500	100	Solution	30.48	54523	801.00	98.53
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
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
t500m10r10-13.pl.json	500	10	Solution	30.28	45925	798.00	98.26
t500m10r10-14.pl.json	500	10	Solution	30.12	41016	799.00	98.05
t500m10r10-15.pl.json	500	10	Solution	30.28	38848	801.00	97.94
t500m10r10-16.pl.json	500	10	Solution	31.63	40674	801.00	98.03
t500m10r10-17.pl.json	500	10	Solution	30.09	38549	798.00	97.93

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m10r10-18.pl.json	500	10	Solution	30.26	39836	801.00	97.99
t500m10r10-19.pl.json	500	10	Solution	30.49	49367	797.00	98.39
t500m10r10-2.pl.json	500	10	Solution	31.15	38579	798.00	97.93
t500m10r10-20.pl.json	500	10	Solution	30.87	42088	801.00	98.10
t500m10r10-3.pl.json	500	10	Solution	30.31	38070	801.00	97.90
t500m10r10-4.pl.json	500	10	Solution	30.26	46184	799.00	98.27
t500m10r10-5.pl.json	500	10	Solution	31.06	47452	799.00	98.32
t500m10r10-6.pl.json	500	10	Solution	30.17	35899	799.00	97.77
t500m10r10-7.pl.json	500	10	Solution	30.64	39279	33091.00	15.75
t500m10r10-8.pl.json	500	10	Solution	30.32	45094	801.00	98.22
t500m10r10-9.pl.json	500	10	Solution	31.96	37640	801.00	97.87
t500m10r3-1.pl.json	500	10	Solution	30.16	38726	801.00	97.93
t500m10r3-10.pl.json	500	10	Solution	30.98	47861	801.00	98.33
t500m10r3-11.pl.json	500	10	Solution	31.01	38763	801.00	97.93
t500m10r3-12.pl.json	500	10	Solution	31.17	41550	800.00	98.07
t500m10r3-13.pl.json	500	10	Solution	30.56	38451	36639.00	4.71
t500m10r3-14.pl.json	500	10	Solution	30.16	39832	799.00	97.99
t500m10r3-15.pl.json	500	10	Solution	31.31	40922	801.00	98.04
t500m10r3-16.pl.json	500	10	Solution	31.25	34687	798.00	97.70
t500m10r3-17.pl.json	500	10	Solution	30.28	48591	801.00	98.35
t500m10r3-18.pl.json	500	10	Solution	32.24	38349	801.00	97.91
t500m10r3-19.pl.json	500	10	Optimal	13.39	49332	49328.00	0.01
t500m10r3-2.pl.json	500	10	Solution	30.14	41108	801.00	98.05
t500m10r3-20.pl.json	500	10	Solution	30.29	47503	801.00	98.31
t500m10r3-3.pl.json	500	10	Solution	30.21	38241	37399.00	2.20
t500m10r3-4.pl.json	500	10	Solution	30.20	48648	801.00	98.35
t500m10r3-5.pl.json	500	10	Solution	30.17	39474	800.00	97.97
t500m10r3-6.pl.json	500	10	Solution	30.56	41357	801.00	98.06
t500m10r3-7.pl.json	500	10	Solution	30.46	37420	800.00	97.86
t500m10r3-8.pl.json	500	10	Solution	30.28	43484	801.00	98.16
t500m10r3-9.pl.json	500	10	Solution	31.26	41905	799.00	98.09
t500m10r5-1.pl.json	500	10	Solution	30.33	41726	801.00	98.08
t500m10r5-10.pl.json	500	10	Solution	30.55	41224	801.00	98.06
t500m10r5-11.pl.json	500	10	Solution	31.07	45156	801.00	98.23
t500m10r5-12.pl.json	500	10	Solution	31.19	36993	801.00	97.83
t500m10r5-13.pl.json	500	10	Solution	30.81	43453	801.00	98.16
t500m10r5-14.pl.json	500	10	Solution	30.28	40022	799.00	98.00
t500m10r5-15.pl.json	500	10	Solution	30.21	39552	801.00	97.97
t500m10r5-16.pl.json	500	10	Solution	30.28	38482	801.00	97.92
t500m10r5-17.pl.json	500	10	Solution	30.13	42266	798.00	98.11
t500m10r5-18.pl.json	500	10	Solution	31.18	42898	798.00	98.14
t500m10r5-19.pl.json	500	10	Solution	30.21	41858	801.00	98.09
t500m10r5-2.pl.json	500	10	Solution	30.47	38818	800.00	97.94
t500m10r5-20.pl.json	500	10	Solution	30.13	47214	799.00	98.31

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m10r5-3.pl.json	500	10	Solution	30.66	42610	800.00	98.12
t500m10r5-4.pl.json	500	10	Solution	30.98	38232	796.00	97.92
t500m10r5-5.pl.json	500	10	Solution	32.41	35577	799.00	97.75
t500m10r5-6.pl.json	500	10	Solution	30.50	42661	801.00	98.12
t500m10r5-7.pl.json	500	10	Solution	31.06	39272	801.00	97.96
t500m10r5-8.pl.json	500	10	Solution	30.20	45732	800.00	98.25
t500m10r5-9.pl.json	500	10	Solution	30.10	40110	800.00	98.01
t500m20r10-1.pl.json	500	20	Solution	30.46	41844	801.00	98.09
t500m20r10-10.pl.json	500	20	Solution	30.25	38682	798.00	97.94
t500m20r10-11.pl.json	500	20	Solution	30.30	38851	799.00	97.94
t500m20r10-12.pl.json	500	20	Solution	30.60	40997	801.00	98.05
t500m20r10-13.pl.json	500	20	Solution	30.80	42326	800.00	98.11
t500m20r10-14.pl.json	500	20	Solution	30.37	40102	798.00	98.01
t500m20r10-15.pl.json	500	20	Solution	30.37	37261	801.00	97.85
t500m20r10-16.pl.json	500	20	Solution	30.31	45059	799.00	98.23
t500m20r10-17.pl.json	500	20	Solution	30.47	40322	801.00	98.01
t500m20r10-18.pl.json	500	20	Solution	30.42	41699	801.00	98.08
t500m20r10-19.pl.json	500	20	Solution	30.41	42802	800.00	98.13
t500m20r10-2.pl.json	500	20	Solution	30.44	46938	801.00	98.29
t500m20r10-20.pl.json	500	20	Solution	30.63	41229	801.00	98.06
t500m20r10-3.pl.json	500	20	Solution	31.61	42399	797.00	98.12
t500m20r10-4.pl.json	500	20	Solution	30.25	35833	801.00	97.76
t500m20r10-5.pl.json	500	20	Solution	31.95	47409	799.00	98.31
t500m20r10-6.pl.json	500	20	Solution	30.28	38270	800.00	97.91
t500m20r10-7.pl.json	500	20	Solution	30.43	33671	800.00	97.62
t500m20r10-8.pl.json	500	20	Solution	30.29	42768	801.00	98.13
t500m20r10-9.pl.json	500	20	Solution	31.70	42752	800.00	98.13
t500m20r3-1.pl.json	500	20	Solution	30.60	37589	800.00	97.87
t500m20r3-10.pl.json	500	20	Solution	30.36	43028	799.00	98.14
t500m20r3-11.pl.json	500	20	Solution	30.25	38845	798.00	97.95
t500m20r3-12.pl.json	500	20	Optimal	20.86	40309	40305.00	0.01
t500m20r3-13.pl.json	500	20	Solution	30.28	33674	801.00	97.62
t500m20r3-14.pl.json	500	20	Solution	31.31	35053	801.00	97.71
t500m20r3-15.pl.json	500	20	Solution	30.48	37738	798.00	97.89
t500m20r3-16.pl.json	500	20	Optimal	10.02	42848	42844.00	0.01
t500m20r3-17.pl.json	500	20	Solution	30.45	39712	801.00	97.98
t500m20r3-18.pl.json	500	20	Optimal	26.11	43126	43122.00	0.01
t500m20r3-19.pl.json	500	20	Solution	30.60	38470	801.00	97.92
t500m20r3-2.pl.json	500	20	Solution	31.20	42503	801.00	98.12
t500m20r3-20.pl.json	500	20	Solution	30.56	45671	796.00	98.26
t500m20r3-3.pl.json	500	20	Solution	31.44	31953	801.00	97.49
t500m20r3-4.pl.json	500	20	Optimal	19.30	43640	43636.00	0.01
t500m20r3-5.pl.json	500	20	Solution	31.71	48450	801.00	98.35
t500m20r3-6.pl.json	500	20	Solution	30.21	35374	799.00	97.74

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m20r3-7.pl.json	500	20	Solution	31.64	45964	796.00	98.27
t500m20r3-8.pl.json	500	20	Solution	31.19	44328	800.00	98.20
t500m20r3-9.pl.json	500	20	Solution	30.76	41079	801.00	98.05
t500m20r5-1.pl.json	500	20	Solution	30.82	36856	801.00	97.83
t500m20r5-10.pl.json	500	20	Solution	34.35	45187	801.00	98.23
t500m20r5-11.pl.json	500	20	Solution	30.26	37707	801.00	97.88
t500m20r5-12.pl.json	500	20	Solution	30.38	37405	800.00	97.86
t500m20r5-13.pl.json	500	20	Solution	31.71	42913	799.00	98.14
t500m20r5-14.pl.json	500	20	Solution	30.23	47228	801.00	98.30
t500m20r5-15.pl.json	500	20	Solution	30.47	40611	801.00	98.03
t500m20r5-16.pl.json	500	20	Solution	30.25	38970	796.00	97.96
t500m20r5-17.pl.json	500	20	Solution	31.62	42158	799.00	98.10
t500m20r5-18.pl.json	500	20	Solution	30.57	43669	800.00	98.17
t500m20r5-19.pl.json	500	20	Solution	32.15	41883	800.00	98.09
t500m20r5-2.pl.json	500	20	Solution	30.51	42467	800.00	98.12
t500m20r5-20.pl.json	500	20	Solution	31.79	37677	801.00	97.87
t500m20r5-3.pl.json	500	20	Solution	31.76	41645	801.00	98.08
t500m20r5-4.pl.json	500	20	Solution	30.15	43010	801.00	98.14
t500m20r5-5.pl.json	500	20	Solution	31.17	43158	801.00	98.14
t500m20r5-6.pl.json	500	20	Solution	32.51	42199	801.00	98.10
t500m20r5-7.pl.json	500	20	Solution	32.83	39535	801.00	97.97
t500m20r5-8.pl.json	500	20	Solution	30.30	44676	801.00	98.21
t500m20r5-9.pl.json	500	20	Solution	31.25	41543	801.00	98.07
t500m50r10-1.pl.json	500	50	Solution	30.78	44568	800.00	98.20
t500m50r10-10.pl.json	500	50	Solution	30.55	41613	800.00	98.08
t500m50r10-11.pl.json	500	50	Solution	30.90	46894	800.00	98.29
t500m50r10-12.pl.json	500	50	Solution	30.37	37026	800.00	97.84
t500m50r10-13.pl.json	500	50	Solution	30.38	34634	799.00	97.69
t500m50r10-14.pl.json	500	50	Solution	30.43	45916	801.00	98.26
t500m50r10-15.pl.json	500	50	Solution	31.36	39306	801.00	97.96
t500m50r10-16.pl.json	500	50	Solution	30.25	36757	801.00	97.82
t500m50r10-17.pl.json	500	50	Solution	31.08	33180	800.00	97.59
t500m50r10-18.pl.json	500	50	Solution	30.64	47233	800.00	98.31
t500m50r10-19.pl.json	500	50	Solution	30.48	42433	801.00	98.11
t500m50r10-2.pl.json	500	50	Solution	30.60	43789	795.00	98.18
t500m50r10-20.pl.json	500	50	Solution	30.76	40950	799.00	98.05
t500m50r10-3.pl.json	500	50	Solution	31.76	42014	801.00	98.09
t500m50r10-4.pl.json	500	50	Solution	30.63	42966	801.00	98.14
t500m50r10-5.pl.json	500	50	Solution	32.16	37220	801.00	97.85
t500m50r10-6.pl.json	500	50	Solution	30.47	33806	799.00	97.64
t500m50r10-7.pl.json	500	50	Solution	30.57	35308	801.00	97.73
t500m50r10-8.pl.json	500	50	Solution	30.57	45479	801.00	98.24
t500m50r10-9.pl.json	500	50	Solution	31.13	39057	801.00	97.95
t500m50r3-1.pl.json	500	50	Solution	30.75	43686	799.00	98.17

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m50r3-10.pl.json	500	50	Solution	30.38	43311	801.00	98.15
t500m50r3-11.pl.json	500	50	Solution	30.52	40856	801.00	98.04
t500m50r3-12.pl.json	500	50	Solution	31.12	38574	800.00	97.93
t500m50r3-13.pl.json	500	50	Solution	30.39	40371	801.00	98.02
t500m50r3-14.pl.json	500	50	Solution	30.71	33849	801.00	97.63
t500m50r3-15.pl.json	500	50	Solution	30.55	39980	801.00	98.00
t500m50r3-16.pl.json	500	50	Solution	31.08	43812	800.00	98.17
t500m50r3-17.pl.json	500	50	Solution	30.64	37519	800.00	97.87
t500m50r3-18.pl.json	500	50	Solution	30.30	42694	800.00	98.13
t500m50r3-19.pl.json	500	50	Solution	30.27	35437	801.00	97.74
t500m50r3-2.pl.json	500	50	Solution	31.61	39303	801.00	97.96
t500m50r3-20.pl.json	500	50	Solution	30.62	42019	801.00	98.09
t500m50r3-3.pl.json	500	50	Solution	30.84	45798	799.00	98.26
t500m50r3-4.pl.json	500	50	Solution	30.67	43883	795.00	98.19
t500m50r3-5.pl.json	500	50	Solution	30.72	45514	801.00	98.24
t500m50r3-6.pl.json	500	50	Solution	31.17	39292	801.00	97.96
t500m50r3-7.pl.json	500	50	Solution	31.28	42541	801.00	98.12
t500m50r3-8.pl.json	500	50	Optimal	14.11	46948	46944.00	0.01
t500m50r3-9.pl.json	500	50	Solution	30.93	46088	798.00	98.27
t500m50r5-1.pl.json	500	50	Solution	30.33	43603	798.00	98.17
t500m50r5-10.pl.json	500	50	Solution	31.41	43308	799.00	98.16
t500m50r5-11.pl.json	500	50	Solution	31.16	45756	799.00	98.25
t500m50r5-12.pl.json	500	50	Solution	30.53	42655	798.00	98.13
t500m50r5-13.pl.json	500	50	Solution	30.57	39240	801.00	97.96
t500m50r5-14.pl.json	500	50	Solution	30.66	41327	800.00	98.06
t500m50r5-15.pl.json	500	50	Solution	30.36	46276	801.00	98.27
t500m50r5-16.pl.json	500	50	Solution	31.01	43409	801.00	98.15
t500m50r5-17.pl.json	500	50	Solution	30.82	37044	799.00	97.84
t500m50r5-18.pl.json	500	50	Solution	31.01	36830	800.00	97.83
t500m50r5-19.pl.json	500	50	Solution	30.65	39841	798.00	98.00
t500m50r5-2.pl.json	500	50	Solution	31.27	42587	801.00	98.12
t500m50r5-20.pl.json	500	50	Solution	31.02	43943	801.00	98.18
t500m50r5-3.pl.json	500	50	Solution	30.34	38800	800.00	97.94
t500m50r5-4.pl.json	500	50	Solution	30.81	34378	801.00	97.67
t500m50r5-5.pl.json	500	50	Solution	30.55	35109	801.00	97.72
t500m50r5-6.pl.json	500	50	Solution	30.66	45567	801.00	98.24
t500m50r5-7.pl.json	500	50	Solution	30.55	45340	797.00	98.24
t500m50r5-8.pl.json	500	50	Solution	30.41	34311	800.00	97.67
t500m50r5-9.pl.json	500	50	Solution	31.20	32817	797.00	97.57
t50m10r10-1.pl.json	50	10	Solution	30.11	6499	5840.00	10.14
t50m10r10-10.pl.json	50	10	Solution	30.27	3396	3172.00	6.60
t50m10r10-11.pl.json	50	10	Solution	30.40	3398	3141.00	7.56
t50m10r10-12.pl.json	50	10	Solution	30.54	7550	6544.00	13.32
t50m10r10-13.pl.json	50	10	Solution	30.55	5484	5191.00	5.34

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t50m10r10-14.pl.json	50	10	Solution	30.27	4666	3431.00	26.47
t50m10r10-15.pl.json	50	10	Solution	30.91	6640	5903.00	11.10
t50m10r10-16.pl.json	50	10	Solution	30.38	4914	4515.00	8.12
t50m10r10-17.pl.json	50	10	Optimal	8.07	2252	2252.00	0.00
t50m10r10-18.pl.json	50	10	Solution	30.74	4034	3841.00	4.78
t50m10r10-19.pl.json	50	10	Solution	30.42	4873	4532.00	7.00
t50m10r10-2.pl.json	50	10	Solution	30.36	4148	3646.00	12.10
t50m10r10-20.pl.json	50	10	Optimal	6.15	3158	3158.00	0.00
t50m10r10-3.pl.json	50	10	Solution	30.40	4334	4190.00	3.32
t50m10r10-4.pl.json	50	10	Solution	30.42	4259	3715.00	12.77
t50m10r10-5.pl.json	50	10	Solution	30.75	2211	2199.00	0.54
t50m10r10-6.pl.json	50	10	Solution	30.32	5752	5457.00	5.13
t50m10r10-7.pl.json	50	10	Solution	30.47	3239	3125.00	3.52
t50m10r10-8.pl.json	50	10	Optimal	10.44	2624	2624.00	0.00
t50m10r10-9.pl.json	50	10	Solution	30.28	5109	5015.00	1.84
t50m10r3-1.pl.json	50	10	Optimal	1.52	7067	7067.00	0.00
t50m10r3-10.pl.json	50	10	Optimal	1.64	4504	4504.00	0.00
t50m10r3-11.pl.json	50	10	Solution	30.38	3856	3811.00	1.17
t50m10r3-12.pl.json	50	10	Optimal	2.46	3063	3063.00	0.00
t50m10r3-13.pl.json	50	10	Optimal	1.56	5368	5368.00	0.00
t50m10r3-14.pl.json	50	10	Optimal	1.56	5759	5759.00	0.00
t50m10r3-15.pl.json	50	10	Optimal	4.99	6360	6360.00	0.00
t50m10r3-16.pl.json	50	10	Optimal	1.98	7616	7616.00	0.00
t50m10r3-17.pl.json	50	10	Solution	30.18	5429	5233.00	3.61
t50m10r3-18.pl.json	50	10	Optimal	1.79	5186	5186.00	0.00
t50m10r3-19.pl.json	50	10	Optimal	2.82	4197	4197.00	0.00
t50m10r3-2.pl.json	50	10	Optimal	1.73	5680	5680.00	0.00
t50m10r3-20.pl.json	50	10	Optimal	2.67	7792	7792.00	0.00
t50m10r3-3.pl.json	50	10	Optimal	5.77	3752	3752.00	0.00
t50m10r3-4.pl.json	50	10	Optimal	3.35	4942	4942.00	0.00
t50m10r3-5.pl.json	50	10	Optimal	1.80	6159	6159.00	0.00
t50m10r3-6.pl.json	50	10	Optimal	4.39	3804	3804.00	0.00
t50m10r3-7.pl.json	50	10	Optimal	2.96	6186	6186.00	0.00
t50m10r3-8.pl.json	50	10	Optimal	2.17	5142	5142.00	0.00
t50m10r3-9.pl.json	50	10	Solution	30.43	7279	7191.00	1.21
t50m10r5-1.pl.json	50	10	Optimal	1.94	5397	5397.00	0.00
t50m10r5-10.pl.json	50	10	Optimal	1.81	4926	4926.00	0.00
t50m10r5-11.pl.json	50	10	Optimal	3.35	3620	3620.00	0.00
t50m10r5-12.pl.json	50	10	Optimal	5.13	5183	5183.00	0.00
t50m10r5-13.pl.json	50	10	Solution	30.36	5716	5394.00	5.63
t50m10r5-14.pl.json	50	10	Optimal	3.28	2828	2828.00	0.00
t50m10r5-15.pl.json	50	10	Solution	30.43	6385	6283.00	1.60
t50m10r5-16.pl.json	50	10	Solution	30.23	4548	3970.00	12.71
t50m10r5-17.pl.json	50	10	Optimal	2.89	5129	5129.00	0.00

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t50m10r5-18.pl.json	50	10	Solution	30.55	5831	5303.00	9.06
t50m10r5-19.pl.json	50	10	Solution	30.37	5552	5213.00	6.11
t50m10r5-2.pl.json	50	10	Optimal	1.70	5153	5153.00	0.00
t50m10r5-20.pl.json	50	10	Solution	30.32	3900	3686.00	5.49
t50m10r5-3.pl.json	50	10	Solution	30.25	4708	4667.00	0.87
t50m10r5-4.pl.json	50	10	Solution	30.36	5551	4986.00	10.18
t50m10r5-5.pl.json	50	10	Optimal	3.36	7451	7451.00	0.00
t50m10r5-6.pl.json	50	10	Optimal	2.76	3781	3781.00	0.00
t50m10r5-7.pl.json	50	10	Solution	30.10	3323	3164.00	4.78
t50m10r5-8.pl.json	50	10	Solution	30.32	5559	4986.00	10.31
t50m10r5-9.pl.json	50	10	Solution	30.21	6385	6082.00	4.75
t50m20r10-1.pl.json	50	20	Solution	30.30	5211	4457.00	14.47
t50m20r10-10.pl.json	50	20	Optimal	3.71	7934	7934.00	0.00
t50m20r10-11.pl.json	50	20	Solution	30.84	5509	5264.00	4.45
t50m20r10-12.pl.json	50	20	Solution	30.38	5023	4256.00	15.27
t50m20r10-13.pl.json	50	20	Optimal	3.51	4143	4143.00	0.00
t50m20r10-14.pl.json	50	20	Optimal	3.25	6048	6048.00	0.00
t50m20r10-15.pl.json	50	20	Solution	30.15	5992	5301.00	11.53
t50m20r10-16.pl.json	50	20	Optimal	5.39	5032	5032.00	0.00
t50m20r10-17.pl.json	50	20	Optimal	3.01	4488	4488.00	0.00
t50m20r10-18.pl.json	50	20	Solution	30.20	4848	4599.00	5.14
t50m20r10-19.pl.json	50	20	Solution	30.38	5430	4555.00	16.11
t50m20r10-2.pl.json	50	20	Solution	30.80	6192	5348.00	13.63
t50m20r10-20.pl.json	50	20	Solution	30.20	6271	5680.00	9.42
t50m20r10-3.pl.json	50	20	Solution	30.90	6582	6278.00	4.62
t50m20r10-4.pl.json	50	20	Solution	31.22	5686	5160.00	9.25
t50m20r10-5.pl.json	50	20	Optimal	4.66	3301	3301.00	0.00
t50m20r10-6.pl.json	50	20	Solution	30.44	4425	795.00	82.03
t50m20r10-7.pl.json	50	20	Optimal	5.62	3519	3519.00	0.00
t50m20r10-8.pl.json	50	20	Solution	30.31	4630	4569.00	1.32
t50m20r10-9.pl.json	50	20	Solution	30.25	5869	5303.00	9.64
t50m20r3-1.pl.json	50	20	Optimal	2.72	3869	3869.00	0.00
t50m20r3-10.pl.json	50	20	Optimal	2.86	3982	3982.00	0.00
t50m20r3-11.pl.json	50	20	Optimal	2.65	4144	4144.00	0.00
t50m20r3-12.pl.json	50	20	Optimal	3.17	2791	2791.00	0.00
t50m20r3-13.pl.json	50	20	Optimal	6.37	6449	6449.00	0.00
t50m20r3-14.pl.json	50	20	Optimal	2.91	4933	4933.00	0.00
t50m20r3-15.pl.json	50	20	Solution	30.45	2436	2218.00	8.95
t50m20r3-16.pl.json	50	20	Optimal	2.72	5872	5872.00	0.00
t50m20r3-17.pl.json	50	20	Optimal	6.52	6880	6880.00	0.00
t50m20r3-18.pl.json	50	20	Optimal	3.21	2811	2811.00	0.00
t50m20r3-19.pl.json	50	20	Optimal	3.25	3465	3465.00	0.00
t50m20r3-2.pl.json	50	20	Optimal	3.02	5570	5570.00	0.00
t50m20r3-20.pl.json	50	20	Optimal	2.42	6364	6364.00	0.00

Table 7.1: Results for Test Scheduling Problems (CPO) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t50m20r3-3.pl.json	50	20	Optimal	2.73	3081	3081.00	0.00
t50m20r3-4.pl.json	50	20	Optimal	2.54	3505	3505.00	0.00
t50m20r3-5.pl.json	50	20	Optimal	2.82	2228	2228.00	0.00
t50m20r3-6.pl.json	50	20	Optimal	4.73	5713	5713.00	0.00
t50m20r3-7.pl.json	50	20	Optimal	3.34	3173	3173.00	0.00
t50m20r3-8.pl.json	50	20	Solution	30.22	3908	3772.00	3.48
t50m20r3-9.pl.json	50	20	Optimal	3.23	4661	4661.00	0.00
t50m20r5-1.pl.json	50	20	Solution	30.23	6273	5304.00	15.45
t50m20r5-10.pl.json	50	20	Optimal	3.06	2328	2328.00	0.00
t50m20r5-11.pl.json	50	20	Optimal	3.05	6403	6403.00	0.00
t50m20r5-12.pl.json	50	20	Optimal	2.81	4281	4281.00	0.00
t50m20r5-13.pl.json	50	20	Optimal	3.17	5754	5754.00	0.00
t50m20r5-14.pl.json	50	20	Solution	30.47	6639	5359.00	19.28
t50m20r5-15.pl.json	50	20	Optimal	2.69	3472	3472.00	0.00
t50m20r5-16.pl.json	50	20	Solution	30.29	5934	5042.00	15.03
t50m20r5-17.pl.json	50	20	Optimal	2.73	4745	4745.00	0.00
t50m20r5-18.pl.json	50	20	Optimal	6.48	3147	3147.00	0.00
t50m20r5-19.pl.json	50	20	Optimal	9.46	5960	5960.00	0.00
t50m20r5-2.pl.json	50	20	Solution	30.38	5547	5417.00	2.34
t50m20r5-20.pl.json	50	20	Optimal	2.75	3913	3913.00	0.00
t50m20r5-3.pl.json	50	20	Solution	30.27	5598	4754.00	15.08
t50m20r5-4.pl.json	50	20	Solution	30.39	5367	4465.00	16.81
t50m20r5-5.pl.json	50	20	Optimal	7.45	3648	3648.00	0.00
t50m20r5-6.pl.json	50	20	Optimal	2.76	5449	5449.00	0.00
t50m20r5-7.pl.json	50	20	Solution	30.13	4127	3794.00	8.07
t50m20r5-8.pl.json	50	20	Solution	30.32	5003	4535.00	9.35
t50m20r5-9.pl.json	50	20	Optimal	3.06	4022	4022.00	0.00

7.2 Results for CPSat

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m10r10-1.pl.json	100	10	Solution	30.04	10491	9055.00	13.69
t100m10r10-10.pl.json	100	10	Solution	30.04	9599	8369.00	12.81
t100m10r10-11.pl.json	100	10	Solution	30.04	5336	5100.00	4.42
t100m10r10-12.pl.json	100	10	Solution	30.04	6564	5613.00	14.49
t100m10r10-13.pl.json	100	10	Solution	30.05	6831	6786.00	0.66
t100m10r10-14.pl.json	100	10	Solution	30.03	5775	5257.00	8.97

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m10r10-15.pl.json	100	10	Solution	30.02	6105	5012.00	17.90
t100m10r10-16.pl.json	100	10	Solution	30.04	12563	11589.00	7.75
t100m10r10-17.pl.json	100	10	Solution	30.05	8954	8114.00	9.38
t100m10r10-18.pl.json	100	10	Solution	30.05	10180	9304.00	8.61
t100m10r10-19.pl.json	100	10	Solution	30.03	9812	8514.00	13.23
t100m10r10-2.pl.json	100	10	Solution	30.02	11593	9807.00	15.41
t100m10r10-20.pl.json	100	10	Solution	30.04	12342	10686.00	13.42
t100m10r10-3.pl.json	100	10	Solution	30.03	6884	6379.00	7.34
t100m10r10-4.pl.json	100	10	Solution	30.03	11041	9111.00	17.48
t100m10r10-5.pl.json	100	10	Solution	30.04	12241	11823.00	3.41
t100m10r10-6.pl.json	100	10	Solution	30.04	11906	10914.00	8.33
t100m10r10-7.pl.json	100	10	Solution	30.05	6435	5732.00	10.92
t100m10r10-8.pl.json	100	10	Solution	30.03	11070	10010.00	9.58
t100m10r10-9.pl.json	100	10	Solution	30.03	9878	7991.00	19.10
t100m10r3-1.pl.json	100	10	Optimal	12.19	8711	8711.00	0.00
t100m10r3-10.pl.json	100	10	Optimal	15.43	8958	8958.00	0.00
t100m10r3-11.pl.json	100	10	Optimal	3.27	9560	9560.00	0.00
t100m10r3-12.pl.json	100	10	Optimal	2.92	7892	7892.00	0.00
t100m10r3-13.pl.json	100	10	Optimal	19.27	10078	10078.00	0.00
t100m10r3-14.pl.json	100	10	Optimal	18.02	8681	8681.00	0.00
t100m10r3-15.pl.json	100	10	Optimal	2.13	8810	8810.00	0.00
t100m10r3-16.pl.json	100	10	Optimal	10.48	11182	11182.00	0.00
t100m10r3-17.pl.json	100	10	Optimal	10.25	7534	7534.00	0.00
t100m10r3-18.pl.json	100	10	Solution	30.05	10376	9934.00	4.26
t100m10r3-19.pl.json	100	10	Solution	30.04	7706	6970.00	9.55
t100m10r3-2.pl.json	100	10	Optimal	1.65	7082	7082.00	0.00
t100m10r3-20.pl.json	100	10	Optimal	0.47	9025	9025.00	0.00
t100m10r3-3.pl.json	100	10	Optimal	3.03	10054	10054.00	0.00
t100m10r3-4.pl.json	100	10	Optimal	1.74	13122	13122.00	0.00
t100m10r3-5.pl.json	100	10	Optimal	13.52	7545	7545.00	0.00
t100m10r3-6.pl.json	100	10	Optimal	14.51	7840	7840.00	0.00
t100m10r3-7.pl.json	100	10	Optimal	3.63	11010	11010.00	0.00
t100m10r3-8.pl.json	100	10	Optimal	5.99	9112	9112.00	0.00
t100m10r3-9.pl.json	100	10	Optimal	11.16	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	12.84	6972	6972.00	0.00
t100m10r5-11.pl.json	100	10	Solution	30.04	9098	8568.00	5.83
t100m10r5-12.pl.json	100	10	Optimal	5.79	6538	6538.00	0.00
t100m10r5-13.pl.json	100	10	Optimal	18.18	8972	8972.00	0.00
t100m10r5-14.pl.json	100	10	Solution	30.03	10539	10347.00	1.82
t100m10r5-15.pl.json	100	10	Solution	30.03	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	4.08	6728	6728.00	0.00
t100m10r5-18.pl.json	100	10	Solution	30.04	9019	8811.00	2.31

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m10r5-19.pl.json	100	10	Optimal	13.99	8885	8885.00	0.00
t100m10r5-2.pl.json	100	10	Optimal	8.51	9010	9010.00	0.00
t100m10r5-20.pl.json	100	10	Optimal	12.69	7022	7022.00	0.00
t100m10r5-3.pl.json	100	10	Solution	30.04	8857	8820.00	0.42
t100m10r5-4.pl.json	100	10	Optimal	22.41	10753	10753.00	0.00
t100m10r5-5.pl.json	100	10	Optimal	11.65	6608	6608.00	0.00
t100m10r5-6.pl.json	100	10	Solution	30.04	9452	8456.00	10.54
t100m10r5-7.pl.json	100	10	Solution	30.04	8186	7664.00	6.38
t100m10r5-8.pl.json	100	10	Solution	30.03	11383	10079.00	11.46
t100m10r5-9.pl.json	100	10	Solution	30.03	11649	10683.00	8.29
t100m20r10-1.pl.json	100	20	Solution	30.06	12643	12180.00	3.66
t100m20r10-10.pl.json	100	20	Solution	30.05	12653	10953.00	13.44
t100m20r10-11.pl.json	100	20	Solution	30.06	8724	7289.00	16.45
t100m20r10-12.pl.json	100	20	Solution	30.05	7404	6774.00	8.51
t100m20r10-13.pl.json	100	20	Solution	30.05	9695	9229.00	4.81
t100m20r10-14.pl.json	100	20	Solution	30.05	10027	8652.00	13.71
t100m20r10-15.pl.json	100	20	Solution	30.05	6544	5362.00	18.06
t100m20r10-16.pl.json	100	20	Solution	30.05	9264	8343.00	9.94
t100m20r10-17.pl.json	100	20	Solution	30.07	8691	7381.00	15.07
t100m20r10-18.pl.json	100	20	Optimal	15.69	4843	4843.00	0.00
t100m20r10-19.pl.json	100	20	Solution	30.05	12320	11752.00	4.61
t100m20r10-2.pl.json	100	20	Solution	30.05	7760	6890.00	11.21
t100m20r10-20.pl.json	100	20	Solution	30.03	10030	8562.00	14.64
t100m20r10-3.pl.json	100	20	Solution	30.06	7133	6295.00	11.75
t100m20r10-4.pl.json	100	20	Solution	30.06	9671	9052.00	6.40
t100m20r10-5.pl.json	100	20	Solution	30.04	9230	8459.00	8.35
t100m20r10-6.pl.json	100	20	Solution	30.06	8781	7619.00	13.23
t100m20r10-7.pl.json	100	20	Solution	30.05	11318	9767.00	13.70
t100m20r10-8.pl.json	100	20	Solution	30.06	7852	7041.00	10.33
t100m20r10-9.pl.json	100	20	Solution	30.05	10856	10019.00	7.71
t100m20r3-1.pl.json	100	20	Optimal	9.73	6585	6585.00	0.00
t100m20r3-10.pl.json	100	20	Optimal	4.77	8535	8535.00	0.00
t100m20r3-11.pl.json	100	20	Optimal	13.99	9084	9084.00	0.00
t100m20r3-12.pl.json	100	20	Optimal	2.36	9066	9066.00	0.00
t100m20r3-13.pl.json	100	20	Solution	30.07	11429	9974.00	12.73
t100m20r3-14.pl.json	100	20	Optimal	8.11	8786	8786.00	0.00
t100m20r3-15.pl.json	100	20	Optimal	12.26	10205	10205.00	0.00
t100m20r3-16.pl.json	100	20	Optimal	10.67	8856	8856.00	0.00
t100m20r3-17.pl.json	100	20	Optimal	10.75	5451	5451.00	0.00
t100m20r3-18.pl.json	100	20	Optimal	11.28	8752	8752.00	0.00
t100m20r3-19.pl.json	100	20	Solution	30.04	8909	8860.00	0.55
t100m20r3-2.pl.json	100	20	Optimal	13.78	8498	8498.00	0.00
t100m20r3-20.pl.json	100	20	Optimal	3.73	7880	7880.00	0.00
t100m20r3-3.pl.json	100	20	Solution	30.04	12192	11987.00	1.68

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m20r3-4.pl.json	100	20	Optimal	18.10	12258	12258.00	0.00
t100m20r3-5.pl.json	100	20	Optimal	7.98	11932	11932.00	0.00
t100m20r3-6.pl.json	100	20	Optimal	10.86	8531	8531.00	0.00
t100m20r3-7.pl.json	100	20	Optimal	7.63	6512	6512.00	0.00
t100m20r3-8.pl.json	100	20	Optimal	18.30	10690	10690.00	0.00
t100m20r3-9.pl.json	100	20	Optimal	2.31	8255	8255.00	0.00
t100m20r5-1.pl.json	100	20	Optimal	12.04	9098	9098.00	0.00
t100m20r5-10.pl.json	100	20	Solution	30.05	8340	7964.00	4.51
t100m20r5-11.pl.json	100	20	Solution	30.05	6828	5564.00	18.51
t100m20r5-12.pl.json	100	20	Solution	30.04	8722	8704.00	0.21
t100m20r5-13.pl.json	100	20	Optimal	16.31	8880	8880.00	0.00
t100m20r5-14.pl.json	100	20	Solution	30.06	10621	9727.00	8.42
t100m20r5-15.pl.json	100	20	Optimal	18.85	8953	8953.00	0.00
t100m20r5-16.pl.json	100	20	Solution	30.05	8020	7594.00	5.31
t100m20r5-17.pl.json	100	20	Solution	30.05	5685	5524.00	2.83
t100m20r5-18.pl.json	100	20	Solution	30.03	6637	6617.00	0.30
t100m20r5-19.pl.json	100	20	Optimal	22.81	9461	9461.00	0.00
t100m20r5-2.pl.json	100	20	Optimal	13.63	9566	9566.00	0.00
t100m20r5-20.pl.json	100	20	Solution	30.03	11569	10228.00	11.59
t100m20r5-3.pl.json	100	20	Solution	30.06	9470	9366.00	1.10
t100m20r5-4.pl.json	100	20	Solution	30.04	14465	12456.00	13.89
t100m20r5-5.pl.json	100	20	Optimal	12.10	8585	8585.00	0.00
t100m20r5-6.pl.json	100	20	Solution	30.05	7528	6539.00	13.14
t100m20r5-7.pl.json	100	20	Solution	30.05	11413	10099.00	11.51
t100m20r5-8.pl.json	100	20	Optimal	17.27	5812	5812.00	0.00
t100m20r5-9.pl.json	100	20	Solution	30.06	6657	6496.00	2.42
t100m50r10-1.pl.json	100	50	Solution	30.10	7299	6941.00	4.90
t100m50r10-10.pl.json	100	50	Solution	30.08	5201	5108.00	1.79
t100m50r10-11.pl.json	100	50	Solution	30.11	4970	4782.00	3.78
t100m50r10-12.pl.json	100	50	Solution	30.12	9335	9122.00	2.28
t100m50r10-13.pl.json	100	50	Solution	30.11	9759	8828.00	9.54
t100m50r10-14.pl.json	100	50	Solution	30.08	10724	8290.00	22.70
t100m50r10-15.pl.json	100	50	Solution	30.08	8640	7804.00	9.68
t100m50r10-16.pl.json	100	50	Solution	30.12	14211	12381.00	12.88
t100m50r10-17.pl.json	100	50	Solution	30.10	9826	9151.00	6.87
t100m50r10-18.pl.json	100	50	Solution	30.09	7384	7120.00	3.58
t100m50r10-19.pl.json	100	50	Solution	30.07	8559	8059.00	5.84
t100m50r10-2.pl.json	100	50	Solution	30.12	7968	7568.00	5.02
t100m50r10-20.pl.json	100	50	Solution	30.11	8421	7939.00	5.72
t100m50r10-3.pl.json	100	50	Optimal	2.98	6937	6937.00	0.00
t100m50r10-4.pl.json	100	50	Solution	30.10	10208	8525.00	16.49
t100m50r10-5.pl.json	100	50	Optimal	18.08	9859	9859.00	0.00
t100m50r10-6.pl.json	100	50	Solution	30.09	7715	6837.00	11.38
t100m50r10-7.pl.json	100	50	Solution	30.10	9691	9542.00	1.54

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t100m50r10-8.pl.json	100	50	Solution	30.13	10719	9176.00	14.39
t100m50r10-9.pl.json	100	50	Solution	30.08	10453	9375.00	10.31
t100m50r3-1.pl.json	100	50	Optimal	10.47	9937	9937.00	0.00
t100m50r3-10.pl.json	100	50	Solution	30.12	8957	8877.00	0.89
t100m50r3-11.pl.json	100	50	Optimal	16.48	6141	6141.00	0.00
t100m50r3-12.pl.json	100	50	Optimal	3.37	6473	6473.00	0.00
t100m50r3-13.pl.json	100	50	Optimal	7.08	8653	8653.00	0.00
t100m50r3-14.pl.json	100	50	Solution	30.07	13039	12796.00	1.86
t100m50r3-15.pl.json	100	50	Solution	30.13	9271	9056.00	2.32
t100m50r3-16.pl.json	100	50	Optimal	15.74	8680	8680.00	0.00
t100m50r3-17.pl.json	100	50	Optimal	5.79	8197	8197.00	0.00
t100m50r3-18.pl.json	100	50	Optimal	6.21	9318	9318.00	0.00
t100m50r3-19.pl.json	100	50	Optimal	4.24	12265	12265.00	0.00
t100m50r3-2.pl.json	100	50	Optimal	25.96	11030	11030.00	0.00
t100m50r3-20.pl.json	100	50	Optimal	2.53	7662	7662.00	0.00
t100m50r3-3.pl.json	100	50	Optimal	2.34	5348	5348.00	0.00
t100m50r3-4.pl.json	100	50	Optimal	14.63	7800	7800.00	0.00
t100m50r3-5.pl.json	100	50	Optimal	13.56	4207	4207.00	0.00
t100m50r3-6.pl.json	100	50	Solution	30.08	10674	10596.00	0.73
t100m50r3-7.pl.json	100	50	Optimal	3.88	7826	7826.00	0.00
t100m50r3-8.pl.json	100	50	Optimal	14.67	7865	7865.00	0.00
t100m50r3-9.pl.json	100	50	Optimal	3.79	7891	7891.00	0.00
t100m50r5-1.pl.json	100	50	Solution	30.07	8016	7926.00	1.12
t100m50r5-10.pl.json	100	50	Solution	30.08	7299	6521.00	10.66
t100m50r5-11.pl.json	100	50	Optimal	18.72	9417	9417.00	0.00
t100m50r5-12.pl.json	100	50	Optimal	4.77	8824	8824.00	0.00
t100m50r5-13.pl.json	100	50	Solution	30.12	10473	9115.00	12.97
t100m50r5-14.pl.json	100	50	Solution	30.08	7503	7134.00	4.92
t100m50r5-15.pl.json	100	50	Solution	30.10	10141	9853.00	2.84
t100m50r5-16.pl.json	100	50	Optimal	9.40	6481	6481.00	0.00
t100m50r5-17.pl.json	100	50	Optimal	5.97	6129	6129.00	0.00
t100m50r5-18.pl.json	100	50	Solution	30.08	9100	8337.00	8.38
t100m50r5-19.pl.json	100	50	Solution	30.09	6762	6356.00	6.00
t100m50r5-2.pl.json	100	50	Optimal	4.94	6651	6651.00	0.00
t100m50r5-20.pl.json	100	50	Solution	30.08	6894	6667.00	3.29
t100m50r5-3.pl.json	100	50	Solution	30.11	7944	7857.00	1.10
t100m50r5-4.pl.json	100	50	Optimal	18.31	8296	8296.00	0.00
t100m50r5-5.pl.json	100	50	Optimal	9.79	9977	9977.00	0.00
t100m50r5-6.pl.json	100	50	Optimal	5.27	8240	8240.00	0.00
t100m50r5-7.pl.json	100	50	Solution	30.11	10917	10904.00	0.12
t100m50r5-8.pl.json	100	50	Optimal	17.90	8293	8293.00	0.00
t100m50r5-9.pl.json	100	50	Solution	30.12	7879	7622.00	3.26
t20m10r10-1.pl.json	20	10	Optimal	0.06	1337	1337.00	0.00
t20m10r10-10.pl.json	20	10	Optimal	0.05	3882	3882.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t20m10r10-11.pl.json	20	10	Optimal	0.08	2002	2002.00	0.00
t20m10r10-12.pl.json	20	10	Optimal	0.05	1257	1257.00	0.00
t20m10r10-13.pl.json	20	10	Optimal	0.08	2110	2110.00	0.00
t20m10r10-14.pl.json	20	10	Optimal	0.04	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	0.68	1643	1643.00	0.00
t20m10r10-17.pl.json	20	10	Optimal	0.06	1069	1069.00	0.00
t20m10r10-18.pl.json	20	10	Optimal	0.06	3041	3041.00	0.00
t20m10r10-19.pl.json	20	10	Optimal	0.05	2422	2422.00	0.00
t20m10r10-2.pl.json	20	10	Optimal	0.07	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	0.07	1396	1396.00	0.00
t20m10r10-5.pl.json	20	10	Optimal	0.07	1710	1710.00	0.00
t20m10r10-6.pl.json	20	10	Optimal	0.06	2434	2434.00	0.00
t20m10r10-7.pl.json	20	10	Optimal	0.12	2696	2696.00	0.00
t20m10r10-8.pl.json	20	10	Optimal	0.05	1329	1329.00	0.00
t20m10r10-9.pl.json	20	10	Optimal	0.93	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	0.06	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	0.07	1758	1758.00	0.00
t20m10r3-13.pl.json	20	10	Optimal	0.06	3099	3099.00	0.00
t20m10r3-14.pl.json	20	10	Optimal	1.76	3891	3891.00	0.00
t20m10r3-15.pl.json	20	10	Optimal	0.07	1433	1433.00	0.00
t20m10r3-16.pl.json	20	10	Optimal	0.06	1564	1564.00	0.00
t20m10r3-17.pl.json	20	10	Optimal	0.06	2321	2321.00	0.00
t20m10r3-18.pl.json	20	10	Solution	30.05	821	746.00	9.14
t20m10r3-19.pl.json	20	10	Optimal	0.07	1236	1236.00	0.00
t20m10r3-2.pl.json	20	10	Optimal	0.06	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	0.04	2255	2255.00	0.00
t20m10r3-4.pl.json	20	10	Optimal	0.09	2707	2707.00	0.00
t20m10r3-5.pl.json	20	10	Optimal	0.06	2381	2381.00	0.00
t20m10r3-6.pl.json	20	10	Optimal	0.07	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	0.18	1278	1278.00	0.00
t20m10r3-9.pl.json	20	10	Optimal	0.05	2874	2874.00	0.00
t20m10r5-1.pl.json	20	10	Optimal	0.06	2586	2586.00	0.00
t20m10r5-10.pl.json	20	10	Optimal	0.07	2260	2260.00	0.00
t20m10r5-11.pl.json	20	10	Optimal	0.05	3487	3487.00	0.00
t20m10r5-12.pl.json	20	10	Optimal	0.05	1559	1559.00	0.00
t20m10r5-13.pl.json	20	10	Optimal	0.06	1457	1457.00	0.00
t20m10r5-14.pl.json	20	10	Optimal	0.08	1141	1141.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t20m10r5-15.pl.json	20	10	Optimal	0.14	821	821.00	0.00
t20m10r5-16.pl.json	20	10	Optimal	0.06	2910	2910.00	0.00
t20m10r5-17.pl.json	20	10	Optimal	0.07	2337	2337.00	0.00
t20m10r5-18.pl.json	20	10	Optimal	0.80	2920	2920.00	0.00
t20m10r5-19.pl.json	20	10	Optimal	0.04	1952	1952.00	0.00
t20m10r5-2.pl.json	20	10	Optimal	0.06	1639	1639.00	0.00
t20m10r5-20.pl.json	20	10	Optimal	0.04	2660	2660.00	0.00
t20m10r5-3.pl.json	20	10	Optimal	0.06	1406	1406.00	0.00
t20m10r5-4.pl.json	20	10	Optimal	0.07	2658	2658.00	0.00
t20m10r5-5.pl.json	20	10	Optimal	0.09	794	794.00	0.00
t20m10r5-6.pl.json	20	10	Optimal	0.06	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	0.09	976	976.00	0.00
t20m10r5-9.pl.json	20	10	Optimal	0.06	2953	2953.00	0.00
t30m10r10-1.pl.json	30	10	Optimal	3.50	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	0.12	2905	2905.00	0.00
t30m10r10-12.pl.json	30	10	Optimal	0.11	3672	3672.00	0.00
t30m10r10-13.pl.json	30	10	Optimal	0.15	2778	2778.00	0.00
t30m10r10-14.pl.json	30	10	Optimal	1.59	2741	2741.00	0.00
t30m10r10-15.pl.json	30	10	Optimal	0.12	2388	2388.00	0.00
t30m10r10-16.pl.json	30	10	Optimal	3.04	4225	4225.00	0.00
t30m10r10-17.pl.json	30	10	Optimal	0.11	1504	1504.00	0.00
t30m10r10-18.pl.json	30	10	Optimal	7.37	3287	3287.00	0.00
t30m10r10-19.pl.json	30	10	Optimal	0.11	3874	3874.00	0.00
t30m10r10-2.pl.json	30	10	Optimal	0.09	3169	3169.00	0.00
t30m10r10-20.pl.json	30	10	Optimal	0.07	2691	2691.00	0.00
t30m10r10-3.pl.json	30	10	Solution	30.02	3360	2851.00	15.15
t30m10r10-4.pl.json	30	10	Optimal	0.08	3452	3452.00	0.00
t30m10r10-5.pl.json	30	10	Optimal	0.08	2785	2785.00	0.00
t30m10r10-6.pl.json	30	10	Solution	30.09	1011	775.00	23.34
t30m10r10-7.pl.json	30	10	Optimal	4.10	3755	3755.00	0.00
t30m10r10-8.pl.json	30	10	Optimal	11.44	4613	4613.00	0.00
t30m10r10-9.pl.json	30	10	Optimal	0.08	2770	2770.00	0.00
t30m10r3-1.pl.json	30	10	Optimal	0.17	2901	2901.00	0.00
t30m10r3-10.pl.json	30	10	Optimal	0.10	4829	4829.00	0.00
t30m10r3-11.pl.json	30	10	Optimal	0.09	2584	2584.00	0.00
t30m10r3-12.pl.json	30	10	Optimal	0.08	2130	2130.00	0.00
t30m10r3-13.pl.json	30	10	Optimal	0.07	4253	4253.00	0.00
t30m10r3-14.pl.json	30	10	Optimal	0.16	1393	1393.00	0.00
t30m10r3-15.pl.json	30	10	Optimal	0.11	4149	4149.00	0.00
t30m10r3-16.pl.json	30	10	Optimal	0.23	2027	2027.00	0.00
t30m10r3-17.pl.json	30	10	Optimal	0.11	2975	2975.00	0.00
t30m10r3-18.pl.json	30	10	Optimal	0.13	5477	5477.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t30m10r3-19.pl.json	30	10	Solution	30.02	1288	1042.00	19.10
t30m10r3-2.pl.json	30	10	Optimal	0.15	2523	2523.00	0.00
t30m10r3-20.pl.json	30	10	Optimal	0.09	4754	4754.00	0.00
t30m10r3-3.pl.json	30	10	Optimal	0.07	2793	2793.00	0.00
t30m10r3-4.pl.json	30	10	Optimal	0.97	2809	2809.00	0.00
t30m10r3-5.pl.json	30	10	Optimal	0.14	3758	3758.00	0.00
t30m10r3-6.pl.json	30	10	Optimal	0.06	2870	2870.00	0.00
t30m10r3-7.pl.json	30	10	Optimal	0.13	2122	2122.00	0.00
t30m10r3-8.pl.json	30	10	Optimal	0.13	2862	2862.00	0.00
t30m10r3-9.pl.json	30	10	Optimal	0.09	2754	2754.00	0.00
t30m10r5-1.pl.json	30	10	Optimal	0.09	1998	1998.00	0.00
t30m10r5-10.pl.json	30	10	Optimal	0.12	3743	3743.00	0.00
t30m10r5-11.pl.json	30	10	Optimal	0.12	2138	2138.00	0.00
t30m10r5-12.pl.json	30	10	Optimal	0.08	2251	2251.00	0.00
t30m10r5-13.pl.json	30	10	Optimal	0.10	2632	2632.00	0.00
t30m10r5-14.pl.json	30	10	Optimal	0.11	2201	2201.00	0.00
t30m10r5-15.pl.json	30	10	Optimal	0.10	2339	2339.00	0.00
t30m10r5-16.pl.json	30	10	Optimal	0.17	4293	4293.00	0.00
t30m10r5-17.pl.json	30	10	Optimal	0.15	1314	1314.00	0.00
t30m10r5-18.pl.json	30	10	Optimal	0.09	2169	2169.00	0.00
t30m10r5-19.pl.json	30	10	Solution	30.14	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	0.18	1486	1486.00	0.00
t30m10r5-3.pl.json	30	10	Optimal	0.08	2494	2494.00	0.00
t30m10r5-4.pl.json	30	10	Optimal	0.11	3405	3405.00	0.00
t30m10r5-5.pl.json	30	10	Optimal	3.99	5243	5243.00	0.00
t30m10r5-6.pl.json	30	10	Optimal	0.09	2382	2382.00	0.00
t30m10r5-7.pl.json	30	10	Optimal	0.10	2018	2018.00	0.00
t30m10r5-8.pl.json	30	10	Optimal	0.13	3089	3089.00	0.00
t30m10r5-9.pl.json	30	10	Optimal	0.12	3704	3704.00	0.00
t30m20r10-1.pl.json	30	20	Solution	30.01	3702	2850.00	23.01
t30m20r10-10.pl.json	30	20	Optimal	0.11	2508	2508.00	0.00
t30m20r10-11.pl.json	30	20	Optimal	1.75	3648	3648.00	0.00
t30m20r10-12.pl.json	30	20	Optimal	0.36	4214	4214.00	0.00
t30m20r10-13.pl.json	30	20	Optimal	6.20	3980	3980.00	0.00
t30m20r10-14.pl.json	30	20	Optimal	0.17	3141	3141.00	0.00
t30m20r10-15.pl.json	30	20	Solution	30.03	4322	3457.00	20.01
t30m20r10-16.pl.json	30	20	Optimal	0.22	4002	4002.00	0.00
t30m20r10-17.pl.json	30	20	Optimal	19.13	4161	4161.00	0.00
t30m20r10-18.pl.json	30	20	Optimal	3.59	1992	1992.00	0.00
t30m20r10-19.pl.json	30	20	Optimal	0.17	2789	2789.00	0.00
t30m20r10-2.pl.json	30	20	Optimal	20.44	3982	3982.00	0.00
t30m20r10-20.pl.json	30	20	Optimal	0.18	2314	2314.00	0.00
t30m20r10-3.pl.json	30	20	Optimal	0.15	2158	2158.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t30m20r10-4.pl.json	30	20	Optimal	6.52	4040	4040.00	0.00
t30m20r10-5.pl.json	30	20	Optimal	0.14	1237	1237.00	0.00
t30m20r10-6.pl.json	30	20	Optimal	3.53	3770	3770.00	0.00
t30m20r10-7.pl.json	30	20	Optimal	0.18	2266	2266.00	0.00
t30m20r10-8.pl.json	30	20	Optimal	0.45	1855	1855.00	0.00
t30m20r10-9.pl.json	30	20	Optimal	0.80	2028	2028.00	0.00
t30m20r3-1.pl.json	30	20	Optimal	0.17	2200	2200.00	0.00
t30m20r3-10.pl.json	30	20	Optimal	0.13	3291	3291.00	0.00
t30m20r3-11.pl.json	30	20	Optimal	0.22	4473	4473.00	0.00
t30m20r3-12.pl.json	30	20	Optimal	3.75	5060	5060.00	0.00
t30m20r3-13.pl.json	30	20	Optimal	0.14	3536	3536.00	0.00
t30m20r3-14.pl.json	30	20	Optimal	0.15	3432	3432.00	0.00
t30m20r3-15.pl.json	30	20	Optimal	0.14	3463	3463.00	0.00
t30m20r3-16.pl.json	30	20	Optimal	0.16	3893	3893.00	0.00
t30m20r3-17.pl.json	30	20	Optimal	0.19	1892	1892.00	0.00
t30m20r3-18.pl.json	30	20	Optimal	0.16	2653	2653.00	0.00
t30m20r3-19.pl.json	30	20	Optimal	0.18	3141	3141.00	0.00
t30m20r3-2.pl.json	30	20	Optimal	0.15	1251	1251.00	0.00
t30m20r3-20.pl.json	30	20	Optimal	2.08	2745	2745.00	0.00
t30m20r3-3.pl.json	30	20	Optimal	0.18	3434	3434.00	0.00
t30m20r3-4.pl.json	30	20	Optimal	0.19	2394	2394.00	0.00
t30m20r3-5.pl.json	30	20	Optimal	0.12	3776	3776.00	0.00
t30m20r3-6.pl.json	30	20	Optimal	0.20	2250	2250.00	0.00
t30m20r3-7.pl.json	30	20	Optimal	0.21	1693	1693.00	0.00
t30m20r3-8.pl.json	30	20	Optimal	0.12	4997	4997.00	0.00
t30m20r3-9.pl.json	30	20	Optimal	0.16	4898	4898.00	0.00
t30m20r5-1.pl.json	30	20	Optimal	2.62	3195	3195.00	0.00
t30m20r5-10.pl.json	30	20	Optimal	0.72	2133	2133.00	0.00
t30m20r5-11.pl.json	30	20	Optimal	0.17	3974	3974.00	0.00
t30m20r5-12.pl.json	30	20	Optimal	0.16	2197	2197.00	0.00
t30m20r5-13.pl.json	30	20	Optimal	0.15	2296	2296.00	0.00
t30m20r5-14.pl.json	30	20	Optimal	0.21	3861	3861.00	0.00
t30m20r5-15.pl.json	30	20	Optimal	0.16	2353	2353.00	0.00
t30m20r5-16.pl.json	30	20	Optimal	1.80	2751	2751.00	0.00
t30m20r5-17.pl.json	30	20	Optimal	0.22	3555	3555.00	0.00
t30m20r5-18.pl.json	30	20	Optimal	0.14	2384	2384.00	0.00
t30m20r5-19.pl.json	30	20	Optimal	0.17	2080	2080.00	0.00
t30m20r5-2.pl.json	30	20	Optimal	0.11	1715	1715.00	0.00
t30m20r5-20.pl.json	30	20	Optimal	0.15	4176	4176.00	0.00
t30m20r5-3.pl.json	30	20	Optimal	15.15	4528	4528.00	0.00
t30m20r5-4.pl.json	30	20	Optimal	0.20	3083	3083.00	0.00
t30m20r5-5.pl.json	30	20	Optimal	0.12	1969	1969.00	0.00
t30m20r5-6.pl.json	30	20	Optimal	0.15	4250	4250.00	0.00
t30m20r5-7.pl.json	30	20	Optimal	0.19	3036	3036.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t30m20r5-8.pl.json	30	20	Optimal	2.07	2834	2834.00	0.00
t30m20r5-9.pl.json	30	20	Optimal	0.16	2343	2343.00	0.00
t40m10r10-1.pl.json	40	10	Optimal	0.18	2514	2514.00	0.00
t40m10r10-10.pl.json	40	10	Optimal	0.18	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	30.04	5225	4355.00	16.65
t40m10r10-13.pl.json	40	10	Optimal	5.66	2789	2789.00	0.00
t40m10r10-14.pl.json	40	10	Optimal	0.34	1648	1648.00	0.00
t40m10r10-15.pl.json	40	10	Optimal	1.53	1844	1844.00	0.00
t40m10r10-16.pl.json	40	10	Optimal	9.44	3749	3749.00	0.00
t40m10r10-17.pl.json	40	10	Optimal	0.15	2363	2363.00	0.00
t40m10r10-18.pl.json	40	10	Optimal	0.23	4973	4973.00	0.00
t40m10r10-19.pl.json	40	10	Optimal	0.26	3181	3181.00	0.00
t40m10r10-2.pl.json	40	10	Optimal	0.24	2350	2350.00	0.00
t40m10r10-20.pl.json	40	10	Optimal	11.15	2730	2730.00	0.00
t40m10r10-3.pl.json	40	10	Optimal	0.17	3717	3717.00	0.00
t40m10r10-4.pl.json	40	10	Optimal	0.17	3414	3414.00	0.00
t40m10r10-5.pl.json	40	10	Optimal	2.53	2852	2852.00	0.00
t40m10r10-6.pl.json	40	10	Optimal	8.05	3262	3262.00	0.00
t40m10r10-7.pl.json	40	10	Optimal	0.15	4572	4572.00	0.00
t40m10r10-8.pl.json	40	10	Optimal	6.04	3776	3776.00	0.00
t40m10r10-9.pl.json	40	10	Optimal	0.34	2524	2524.00	0.00
t40m10r3-1.pl.json	40	10	Optimal	0.17	4832	4832.00	0.00
t40m10r3-10.pl.json	40	10	Optimal	0.12	2442	2442.00	0.00
t40m10r3-11.pl.json	40	10	Optimal	0.52	3218	3218.00	0.00
t40m10r3-12.pl.json	40	10	Optimal	0.11	3863	3863.00	0.00
t40m10r3-13.pl.json	40	10	Optimal	0.41	3564	3564.00	0.00
t40m10r3-14.pl.json	40	10	Optimal	0.15	4913	4913.00	0.00
t40m10r3-15.pl.json	40	10	Optimal	0.21	3785	3785.00	0.00
t40m10r3-16.pl.json	40	10	Optimal	0.37	2840	2840.00	0.00
t40m10r3-17.pl.json	40	10	Optimal	0.20	5506	5506.00	0.00
t40m10r3-18.pl.json	40	10	Optimal	0.38	3848	3848.00	0.00
t40m10r3-19.pl.json	40	10	Optimal	0.27	2259	2259.00	0.00
t40m10r3-2.pl.json	40	10	Solution	30.18	1729	1589.00	8.10
t40m10r3-20.pl.json	40	10	Optimal	0.26	4157	4157.00	0.00
t40m10r3-3.pl.json	40	10	Optimal	0.33	4903	4903.00	0.00
t40m10r3-4.pl.json	40	10	Solution	30.02	1633	1341.00	17.88
t40m10r3-5.pl.json	40	10	Optimal	0.34	1984	1984.00	0.00
t40m10r3-6.pl.json	40	10	Optimal	0.35	5005	5005.00	0.00
t40m10r3-7.pl.json	40	10	Solution	30.02	5545	5188.00	6.44
t40m10r3-8.pl.json	40	10	Optimal	0.24	3658	3658.00	0.00
t40m10r3-9.pl.json	40	10	Optimal	0.36	3830	3830.00	0.00
t40m10r5-1.pl.json	40	10	Optimal	0.20	4857	4857.00	0.00
t40m10r5-10.pl.json	40	10	Optimal	0.20	3989	3989.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t40m10r5-11.pl.json	40	10	Optimal	0.33	5238	5238.00	0.00
t40m10r5-12.pl.json	40	10	Optimal	0.42	4584	4584.00	0.00
t40m10r5-13.pl.json	40	10	Optimal	0.40	2307	2307.00	0.00
t40m10r5-14.pl.json	40	10	Optimal	0.21	1826	1826.00	0.00
t40m10r5-15.pl.json	40	10	Optimal	0.17	1926	1926.00	0.00
t40m10r5-16.pl.json	40	10	Optimal	0.26	5216	5216.00	0.00
t40m10r5-17.pl.json	40	10	Optimal	0.14	7162	7162.00	0.00
t40m10r5-18.pl.json	40	10	Optimal	0.24	4892	4892.00	0.00
t40m10r5-19.pl.json	40	10	Optimal	0.18	4027	4027.00	0.00
t40m10r5-2.pl.json	40	10	Optimal	3.51	4099	4099.00	0.00
t40m10r5-20.pl.json	40	10	Optimal	10.41	4899	4899.00	0.00
t40m10r5-3.pl.json	40	10	Optimal	0.64	3113	3113.00	0.00
t40m10r5-4.pl.json	40	10	Optimal	0.21	6626	6626.00	0.00
t40m10r5-5.pl.json	40	10	Optimal	0.25	3828	3828.00	0.00
t40m10r5-6.pl.json	40	10	Optimal	0.33	4213	4213.00	0.00
t40m10r5-7.pl.json	40	10	Optimal	0.21	4303	4303.00	0.00
t40m10r5-8.pl.json	40	10	Solution	30.02	3559	3189.00	10.40
t40m10r5-9.pl.json	40	10	Optimal	0.30	1953	1953.00	0.00
t40m20r10-1.pl.json	40	20	Solution	30.05	4518	3972.00	12.08
t40m20r10-10.pl.json	40	20	Optimal	4.24	3862	3862.00	0.00
t40m20r10-11.pl.json	40	20	Optimal	0.21	1952	1952.00	0.00
t40m20r10-12.pl.json	40	20	Optimal	0.71	4129	4129.00	0.00
t40m20r10-13.pl.json	40	20	Optimal	0.23	2927	2927.00	0.00
t40m20r10-14.pl.json	40	20	Optimal	6.14	2701	2701.00	0.00
t40m20r10-15.pl.json	40	20	Optimal	6.72	3168	3168.00	0.00
t40m20r10-16.pl.json	40	20	Optimal	0.15	2812	2812.00	0.00
t40m20r10-17.pl.json	40	20	Optimal	8.83	4288	4288.00	0.00
t40m20r10-18.pl.json	40	20	Optimal	8.25	3611	3611.00	0.00
t40m20r10-19.pl.json	40	20	Optimal	1.71	2891	2891.00	0.00
t40m20r10-2.pl.json	40	20	Optimal	0.16	3284	3284.00	0.00
t40m20r10-20.pl.json	40	20	Optimal	23.67	5506	5506.00	0.00
t40m20r10-3.pl.json	40	20	Solution	30.03	5981	5478.00	8.41
t40m20r10-4.pl.json	40	20	Optimal	0.16	3409	3409.00	0.00
t40m20r10-5.pl.json	40	20	Solution	30.04	5113	4278.00	16.33
t40m20r10-6.pl.json	40	20	Optimal	21.04	2376	2376.00	0.00
t40m20r10-7.pl.json	40	20	Optimal	18.53	4799	4799.00	0.00
t40m20r10-8.pl.json	40	20	Optimal	6.17	3924	3924.00	0.00
t40m20r10-9.pl.json	40	20	Optimal	4.28	2043	2043.00	0.00
t40m20r3-1.pl.json	40	20	Optimal	0.26	3524	3524.00	0.00
t40m20r3-10.pl.json	40	20	Optimal	0.60	3110	3110.00	0.00
t40m20r3-11.pl.json	40	20	Optimal	0.22	3695	3695.00	0.00
t40m20r3-12.pl.json	40	20	Optimal	0.31	4828	4828.00	0.00
t40m20r3-13.pl.json	40	20	Optimal	0.35	4010	4010.00	0.00
t40m20r3-14.pl.json	40	20	Optimal	0.14	2752	2752.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t40m20r3-15.pl.json	40	20	Optimal	0.22	3312	3312.00	0.00
t40m20r3-16.pl.json	40	20	Optimal	0.41	4304	4304.00	0.00
t40m20r3-17.pl.json	40	20	Optimal	0.29	3991	3991.00	0.00
t40m20r3-18.pl.json	40	20	Optimal	0.27	5733	5733.00	0.00
t40m20r3-19.pl.json	40	20	Optimal	0.24	3581	3581.00	0.00
t40m20r3-2.pl.json	40	20	Optimal	0.30	4869	4869.00	0.00
t40m20r3-20.pl.json	40	20	Optimal	0.34	3514	3514.00	0.00
t40m20r3-3.pl.json	40	20	Optimal	0.27	2503	2503.00	0.00
t40m20r3-4.pl.json	40	20	Optimal	0.21	4323	4323.00	0.00
t40m20r3-5.pl.json	40	20	Optimal	0.29	3626	3626.00	0.00
t40m20r3-6.pl.json	40	20	Optimal	0.22	2488	2488.00	0.00
t40m20r3-7.pl.json	40	20	Optimal	0.16	3470	3470.00	0.00
t40m20r3-8.pl.json	40	20	Optimal	0.84	6730	6730.00	0.00
t40m20r3-9.pl.json	40	20	Optimal	0.23	4656	4656.00	0.00
t40m20r5-1.pl.json	40	20	Optimal	0.20	1318	1318.00	0.00
t40m20r5-10.pl.json	40	20	Optimal	0.27	2216	2216.00	0.00
t40m20r5-11.pl.json	40	20	Optimal	0.23	3538	3538.00	0.00
t40m20r5-12.pl.json	40	20	Optimal	0.33	5346	5346.00	0.00
t40m20r5-13.pl.json	40	20	Optimal	21.99	4589	4589.00	0.00
t40m20r5-14.pl.json	40	20	Optimal	0.21	2243	2243.00	0.00
t40m20r5-15.pl.json	40	20	Optimal	8.96	3869	3869.00	0.00
t40m20r5-16.pl.json	40	20	Optimal	0.28	4319	4319.00	0.00
t40m20r5-17.pl.json	40	20	Optimal	0.21	4866	4866.00	0.00
t40m20r5-18.pl.json	40	20	Optimal	0.66	5802	5802.00	0.00
t40m20r5-19.pl.json	40	20	Optimal	10.46	4197	4197.00	0.00
t40m20r5-2.pl.json	40	20	Optimal	0.17	2634	2634.00	0.00
t40m20r5-20.pl.json	40	20	Solution	30.05	6482	6232.00	3.86
t40m20r5-3.pl.json	40	20	Optimal	0.38	4391	4391.00	0.00
t40m20r5-4.pl.json	40	20	Optimal	5.34	4610	4610.00	0.00
t40m20r5-5.pl.json	40	20	Optimal	0.17	3105	3105.00	0.00
t40m20r5-6.pl.json	40	20	Optimal	0.21	4760	4760.00	0.00
t40m20r5-7.pl.json	40	20	Optimal	0.22	1218	1218.00	0.00
t40m20r5-8.pl.json	40	20	Optimal	0.20	2601	2601.00	0.00
t40m20r5-9.pl.json	40	20	Optimal	0.17	3141	3141.00	0.00
t500m100r10-1.pl.json	500	100	Solution	34.47	99985	44508.00	55.49
t500m100r10-10.pl.json	500	100	Solution	36.70	99989	35930.00	64.07
t500m100r10-11.pl.json	500	100	Solution	37.37	99998	31878.00	68.12
t500m100r10-12.pl.json	500	100	Solution	41.73	99997	44533.00	55.47
t500m100r10-13.pl.json	500	100	Solution	40.49	99999	37955.00	62.04
t500m100r10-14.pl.json	500	100	Solution	36.97	99990	34723.00	65.27
t500m100r10-15.pl.json	500	100	Solution	40.76	100000	35403.00	64.60
t500m100r10-16.pl.json	500	100	Solution	39.01	99999	33693.00	66.31
t500m100r10-17.pl.json	500	100	Solution	42.46	99997	28688.00	71.31
t500m100r10-18.pl.json	500	100	Solution	42.66	100000	37334.00	62.67

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m100r10-19.pl.json	500	100	Solution	43.40	100000	40128.00	59.87
t500m100r10-2.pl.json	500	100	Solution	43.11	100000	37597.00	62.40
t500m100r10-20.pl.json	500	100	Solution	42.96	100000	30194.00	69.81
t500m100r10-3.pl.json	500	100	Solution	43.67	99999	31662.00	68.34
t500m100r10-4.pl.json	500	100	Solution	43.11	99993	35350.00	64.65
t500m100r10-5.pl.json	500	100	Solution	44.75	99996	30335.00	69.66
t500m100r10-6.pl.json	500	100	Solution	41.60	99986	35654.00	64.34
t500m100r10-7.pl.json	500	100	Solution	89.79	99991	35760.00	64.24
t500m100r10-8.pl.json	500	100	Solution	81.73	99990	37775.00	62.22
t500m100r10-9.pl.json	500	100	Solution	43.73	100000	34951.00	65.05
t500m100r3-1.pl.json	500	100	Solution	42.91	99985	37887.00	62.11
t500m100r3-10.pl.json	500	100	Solution	43.92	99993	41592.00	58.41
t500m100r3-11.pl.json	500	100	Solution	46.47	99996	36331.00	63.67
t500m100r3-12.pl.json	500	100	Solution	45.82	100000	36704.00	63.30
t500m100r3-13.pl.json	500	100	Solution	42.12	99995	35381.00	64.62
t500m100r3-14.pl.json	500	100	Solution	88.74	99982	40411.00	59.58
t500m100r3-15.pl.json	500	100	Solution	44.26	99992	38658.00	61.34
t500m100r3-16.pl.json	500	100	Solution	93.53	99986	39443.00	60.55
t500m100r3-17.pl.json	500	100	Solution	42.16	99994	54487.00	45.51
t500m100r3-18.pl.json	500	100	Solution	91.03	100000	38068.00	61.93
t500m100r3-19.pl.json	500	100	Solution	48.15	100000	41896.00	58.10
t500m100r3-2.pl.json	500	100	Solution	48.01	99993	41211.00	58.79
t500m100r3-20.pl.json	500	100	Solution	42.84	100000	37671.00	62.33
t500m100r3-3.pl.json	500	100	Solution	88.52	99990	35084.00	64.91
t500m100r3-4.pl.json	500	100	Solution	47.32	99997	32016.00	67.98
t500m100r3-5.pl.json	500	100	Solution	47.73	100000	38298.00	61.70
t500m100r3-6.pl.json	500	100	Solution	44.73	99979	46003.00	53.99
t500m100r3-7.pl.json	500	100	Solution	47.33	99998	37262.00	62.74
t500m100r3-8.pl.json	500	100	Solution	46.35	99996	40827.00	59.17
t500m100r3-9.pl.json	500	100	Solution	44.71	99998	44625.00	55.37
t500m100r5-1.pl.json	500	100	Solution	34.78	99995	34446.00	65.55
t500m100r5-10.pl.json	500	100	Solution	37.04	100000	27639.00	72.36
t500m100r5-11.pl.json	500	100	Solution	35.72	100000	35280.00	64.72
t500m100r5-12.pl.json	500	100	Solution	31.74	99993	37187.00	62.81
t500m100r5-13.pl.json	500	100	Solution	39.48	99998	43728.00	56.27
t500m100r5-14.pl.json	500	100	Solution	37.64	100000	38862.00	61.14
t500m100r5-15.pl.json	500	100	Solution	37.56	99991	36096.00	63.90
t500m100r5-16.pl.json	500	100	Solution	41.37	100000	34669.00	65.33
t500m100r5-17.pl.json	500	100	Solution	41.38	99999	37944.00	62.06
t500m100r5-18.pl.json	500	100	Solution	41.58	99996	42744.00	57.25
t500m100r5-19.pl.json	500	100	Solution	42.75	99997	44310.00	55.69
t500m100r5-2.pl.json	500	100	Solution	41.26	99999	40905.00	59.09
t500m100r5-20.pl.json	500	100	Solution	41.73	99999	38404.00	61.60
t500m100r5-3.pl.json	500	100	Solution	43.39	99997	38651.00	61.35

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m100r5-4.pl.json	500	100	Solution	43.76	99991	30938.00	69.06
t500m100r5-5.pl.json	500	100	Solution	38.67	100000	37915.00	62.09
t500m100r5-6.pl.json	500	100	Solution	44.47	99984	40363.00	59.63
t500m100r5-7.pl.json	500	100	Solution	43.93	99992	40749.00	59.25
t500m100r5-8.pl.json	500	100	Solution	46.34	100000	37050.00	62.95
t500m100r5-9.pl.json	500	100	Solution	44.35	99992	39160.00	60.84
t500m10r10-1.pl.json	500	10	Solution	30.11	95746	42756.00	55.34
t500m10r10-10.pl.json	500	10	Solution	30.08	95000	30745.00	67.64
t500m10r10-11.pl.json	500	10	Solution	30.06	94588	42832.00	54.72
t500m10r10-12.pl.json	500	10	Solution	30.09	93713	35908.00	61.68
t500m10r10-13.pl.json	500	10	Solution	30.07	95952	38554.00	59.82
t500m10r10-14.pl.json	500	10	Solution	30.06	94768	34152.00	63.96
t500m10r10-15.pl.json	500	10	Solution	30.07	96018	32118.00	66.55
t500m10r10-16.pl.json	500	10	Solution	30.07	94780	32243.00	65.98
t500m10r10-17.pl.json	500	10	Solution	30.07	96565	32882.00	65.95
t500m10r10-18.pl.json	500	10	Solution	30.08	94982	33101.00	65.15
t500m10r10-19.pl.json	500	10	Solution	30.07	95235	40550.00	57.42
t500m10r10-2.pl.json	500	10	Solution	30.06	93974	34094.00	63.72
t500m10r10-20.pl.json	500	10	Solution	30.09	94572	36034.00	61.90
t500m10r10-3.pl.json	500	10	Solution	30.06	95991	34790.00	63.76
t500m10r10-4.pl.json	500	10	Solution	30.05	94949	40391.00	57.46
t500m10r10-5.pl.json	500	10	Solution	30.09	96784	40910.00	57.73
t500m10r10-6.pl.json	500	10	Solution	30.07	94288	31591.00	66.50
t500m10r10-7.pl.json	500	10	Solution	30.06	96950	33091.00	65.87
t500m10r10-8.pl.json	500	10	Solution	30.05	95149	37700.00	60.38
t500m10r10-9.pl.json	500	10	Solution	30.07	93849	31331.00	66.62
t500m10r3-1.pl.json	500	10	Solution	30.06	92705	38470.00	58.50
t500m10r3-10.pl.json	500	10	Solution	30.06	96160	46481.00	51.66
t500m10r3-11.pl.json	500	10	Solution	30.10	95135	37621.00	60.46
t500m10r3-12.pl.json	500	10	Solution	30.06	93775	41276.00	55.98
t500m10r3-13.pl.json	500	10	Solution	30.06	96699	36639.00	62.11
t500m10r3-14.pl.json	500	10	Solution	30.09	95937	39052.00	59.29
t500m10r3-15.pl.json	500	10	Solution	30.08	96302	40506.00	57.94
t500m10r3-16.pl.json	500	10	Solution	30.08	94188	32654.00	65.33
t500m10r3-17.pl.json	500	10	Solution	30.09	94889	48574.00	48.81
t500m10r3-18.pl.json	500	10	Solution	30.07	94265	37386.00	60.34
t500m10r3-19.pl.json	500	10	Solution	30.06	95914	49330.00	48.57
t500m10r3-2.pl.json	500	10	Solution	30.16	97153	40595.00	58.22
t500m10r3-20.pl.json	500	10	Solution	30.07	92943	46331.00	50.15
t500m10r3-3.pl.json	500	10	Solution	30.08	94467	37399.00	60.41
t500m10r3-4.pl.json	500	10	Solution	30.05	97560	48637.00	50.15
t500m10r3-5.pl.json	500	10	Solution	30.07	94536	38945.00	58.80
t500m10r3-6.pl.json	500	10	Solution	30.06	96686	39113.00	59.55
t500m10r3-7.pl.json	500	10	Solution	30.09	96742	36212.00	62.57

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m10r3-8.pl.json	500	10	Solution	30.14	94423	42992.00	54.47
t500m10r3-9.pl.json	500	10	Solution	30.06	94916	41201.00	56.59
t500m10r5-1.pl.json	500	10	Solution	30.07	95693	38422.00	59.85
t500m10r5-10.pl.json	500	10	Solution	30.10	96968	40616.00	58.11
t500m10r5-11.pl.json	500	10	Solution	30.05	96445	43447.00	54.95
t500m10r5-12.pl.json	500	10	Solution	30.06	96045	35447.00	63.09
t500m10r5-13.pl.json	500	10	Solution	30.08	95556	41212.00	56.87
t500m10r5-14.pl.json	500	10	Solution	30.05	95732	37546.00	60.78
t500m10r5-15.pl.json	500	10	Solution	30.08	77582	36409.00	53.07
t500m10r5-16.pl.json	500	10	Solution	30.09	94243	37966.00	59.71
t500m10r5-17.pl.json	500	10	Solution	30.08	95414	41333.00	56.68
t500m10r5-18.pl.json	500	10	Solution	30.07	95623	40205.00	57.95
t500m10r5-19.pl.json	500	10	Solution	30.06	94847	38862.00	59.03
t500m10r5-2.pl.json	500	10	Solution	30.08	95895	36135.00	62.32
t500m10r5-20.pl.json	500	10	Solution	30.08	94987	42789.00	54.95
t500m10r5-3.pl.json	500	10	Solution	30.08	94696	41375.00	56.31
t500m10r5-4.pl.json	500	10	Solution	30.08	95774	34710.00	63.76
t500m10r5-5.pl.json	500	10	Solution	30.06	95351	33781.00	64.57
t500m10r5-6.pl.json	500	10	Solution	30.06	94254	41208.00	56.28
t500m10r5-7.pl.json	500	10	Solution	30.08	71786	37543.00	47.70
t500m10r5-8.pl.json	500	10	Solution	30.06	94893	40616.00	57.20
t500m10r5-9.pl.json	500	10	Solution	30.06	93998	37557.00	60.04
t500m20r10-1.pl.json	500	20	Solution	30.14	97697	35120.00	64.05
t500m20r10-10.pl.json	500	20	Solution	30.11	97516	34269.00	64.86
t500m20r10-11.pl.json	500	20	Solution	30.13	97580	33469.00	65.70
t500m20r10-12.pl.json	500	20	Solution	30.13	95009	36943.00	61.12
t500m20r10-13.pl.json	500	20	Solution	30.11	98196	36175.00	63.16
t500m20r10-14.pl.json	500	20	Solution	30.19	94915	34601.00	63.55
t500m20r10-15.pl.json	500	20	Solution	30.11	96944	32963.00	66.00
t500m20r10-16.pl.json	500	20	Solution	30.25	95596	37875.00	60.38
t500m20r10-17.pl.json	500	20	Solution	30.10	96973	34515.00	64.41
t500m20r10-18.pl.json	500	20	Solution	30.14	97844	35137.00	64.09
t500m20r10-19.pl.json	500	20	Solution	30.14	96900	37146.00	61.67
t500m20r10-2.pl.json	500	20	Solution	30.12	95672	39857.00	58.34
t500m20r10-20.pl.json	500	20	Solution	30.14	96470	35785.00	62.91
t500m20r10-3.pl.json	500	20	Solution	30.15	95282	35332.00	62.92
t500m20r10-4.pl.json	500	20	Solution	30.13	96463	30197.00	68.70
t500m20r10-5.pl.json	500	20	Solution	30.16	97742	39933.00	59.14
t500m20r10-6.pl.json	500	20	Solution	30.25	96682	33282.00	65.58
t500m20r10-7.pl.json	500	20	Solution	30.10	95513	30485.00	68.08
t500m20r10-8.pl.json	500	20	Solution	30.11	97048	37688.00	61.17
t500m20r10-9.pl.json	500	20	Solution	30.17	95122	40863.00	57.04
t500m20r3-1.pl.json	500	20	Solution	30.11	96331	36188.00	62.43
t500m20r3-10.pl.json	500	20	Solution	30.13	95729	42859.00	55.23

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m20r3-11.pl.json	500	20	Solution	30.11	95560	38401.00	59.81
t500m20r3-12.pl.json	500	20	Solution	30.12	95608	40309.00	57.84
t500m20r3-13.pl.json	500	20	Solution	30.11	97160	33374.00	65.65
t500m20r3-14.pl.json	500	20	Solution	30.10	47664	34978.00	26.62
t500m20r3-15.pl.json	500	20	Solution	30.25	94244	37664.00	60.04
t500m20r3-16.pl.json	500	20	Solution	30.13	95521	42848.00	55.14
t500m20r3-17.pl.json	500	20	Solution	30.15	97072	39524.00	59.28
t500m20r3-18.pl.json	500	20	Solution	30.11	95122	43126.00	54.66
t500m20r3-19.pl.json	500	20	Solution	30.11	44926	37033.00	17.57
t500m20r3-2.pl.json	500	20	Solution	30.12	96028	42127.00	56.13
t500m20r3-20.pl.json	500	20	Solution	30.10	94804	45628.00	51.87
t500m20r3-3.pl.json	500	20	Solution	30.25	97763	31170.00	68.12
t500m20r3-4.pl.json	500	20	Solution	30.11	94497	43640.00	53.82
t500m20r3-5.pl.json	500	20	Solution	30.15	96748	48397.00	49.98
t500m20r3-6.pl.json	500	20	Solution	30.11	96780	35195.00	63.63
t500m20r3-7.pl.json	500	20	Solution	30.12	96251	45611.00	52.61
t500m20r3-8.pl.json	500	20	Solution	30.25	97074	44320.00	54.34
t500m20r3-9.pl.json	500	20	Solution	30.11	95614	41018.00	57.10
t500m20r5-1.pl.json	500	20	Solution	30.25	97130	35280.00	63.68
t500m20r5-10.pl.json	500	20	Solution	30.11	96985	42735.00	55.94
t500m20r5-11.pl.json	500	20	Solution	30.13	94840	33780.00	64.38
t500m20r5-12.pl.json	500	20	Solution	30.11	94597	37117.00	60.76
t500m20r5-13.pl.json	500	20	Solution	30.13	97220	39429.00	59.44
t500m20r5-14.pl.json	500	20	Solution	30.11	96568	45311.00	53.08
t500m20r5-15.pl.json	500	20	Solution	30.12	95130	38015.00	60.04
t500m20r5-16.pl.json	500	20	Solution	30.15	94779	36087.00	61.93
t500m20r5-17.pl.json	500	20	Solution	30.11	98195	41447.00	57.79
t500m20r5-18.pl.json	500	20	Solution	30.13	94881	40783.00	57.02
t500m20r5-19.pl.json	500	20	Solution	30.11	95921	40972.00	57.29
t500m20r5-2.pl.json	500	20	Solution	30.12	95081	39591.00	58.36
t500m20r5-20.pl.json	500	20	Solution	30.14	95319	37542.00	60.61
t500m20r5-3.pl.json	500	20	Solution	30.14	95802	39647.00	58.62
t500m20r5-4.pl.json	500	20	Solution	30.23	96496	40300.00	58.24
t500m20r5-5.pl.json	500	20	Solution	30.16	96540	41014.00	57.52
t500m20r5-6.pl.json	500	20	Solution	30.13	94656	41439.00	56.22
t500m20r5-7.pl.json	500	20	Solution	30.14	96949	37547.00	61.27
t500m20r5-8.pl.json	500	20	Solution	30.11	95312	41282.00	56.69
t500m20r5-9.pl.json	500	20	Solution	30.20	95186	39384.00	58.62
t500m50r10-1.pl.json	500	50	Solution	30.26	98574	39376.00	60.05
t500m50r10-10.pl.json	500	50	Solution	30.53	97898	34844.00	64.41
t500m50r10-11.pl.json	500	50	Solution	30.31	97432	39722.00	59.23
t500m50r10-12.pl.json	500	50	Solution	30.27	97544	32276.00	66.91
t500m50r10-13.pl.json	500	50	Solution	30.33	98339	29550.00	69.95
t500m50r10-14.pl.json	500	50	Solution	34.32	97956	37824.00	61.39

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m50r10-15.pl.json	500	50	Solution	30.30	97960	33997.00	65.30
t500m50r10-16.pl.json	500	50	Solution	30.55	99118	31567.00	68.15
t500m50r10-17.pl.json	500	50	Solution	30.30	99163	28277.00	71.48
t500m50r10-18.pl.json	500	50	Solution	30.41	98458	39127.00	60.26
t500m50r10-19.pl.json	500	50	Solution	30.30	96340	38100.00	60.45
t500m50r10-2.pl.json	500	50	Solution	34.68	97717	37318.00	61.81
t500m50r10-20.pl.json	500	50	Solution	30.49	97088	32654.00	66.37
t500m50r10-3.pl.json	500	50	Solution	30.25	97120	36737.00	62.17
t500m50r10-4.pl.json	500	50	Solution	30.35	98732	36302.00	63.23
t500m50r10-5.pl.json	500	50	Solution	34.52	98061	31982.00	67.39
t500m50r10-6.pl.json	500	50	Solution	30.34	96562	28608.00	70.37
t500m50r10-7.pl.json	500	50	Solution	30.55	96332	30074.00	68.78
t500m50r10-8.pl.json	500	50	Solution	30.28	97888	39978.00	59.16
t500m50r10-9.pl.json	500	50	Solution	30.33	96470	35216.00	63.50
t500m50r3-1.pl.json	500	50	Solution	30.29	96953	43548.00	55.08
t500m50r3-10.pl.json	500	50	Solution	34.27	96965	43200.00	55.45
t500m50r3-11.pl.json	500	50	Solution	30.47	97740	40426.00	58.64
t500m50r3-12.pl.json	500	50	Solution	30.28	97264	36948.00	62.01
t500m50r3-13.pl.json	500	50	Solution	30.30	97299	38482.00	60.45
t500m50r3-14.pl.json	500	50	Solution	30.26	95702	33747.00	64.74
t500m50r3-15.pl.json	500	50	Solution	30.44	95916	39597.00	58.72
t500m50r3-16.pl.json	500	50	Solution	34.46	97474	42361.00	56.54
t500m50r3-17.pl.json	500	50	Solution	30.47	98815	36939.00	62.62
t500m50r3-18.pl.json	500	50	Solution	30.33	97270	42601.00	56.20
t500m50r3-19.pl.json	500	50	Solution	30.27	97126	34933.00	64.03
t500m50r3-2.pl.json	500	50	Solution	34.38	97040	39261.00	59.54
t500m50r3-20.pl.json	500	50	Solution	30.32	97582	41275.00	57.70
t500m50r3-3.pl.json	500	50	Solution	34.67	98223	45600.00	53.58
t500m50r3-4.pl.json	500	50	Solution	30.50	97899	43554.00	55.51
t500m50r3-5.pl.json	500	50	Solution	30.33	98115	44963.00	54.17
t500m50r3-6.pl.json	500	50	Solution	30.31	97331	38374.00	60.57
t500m50r3-7.pl.json	500	50	Solution	30.30	96331	41410.00	57.01
t500m50r3-8.pl.json	500	50	Solution	30.35	97725	46945.00	51.96
t500m50r3-9.pl.json	500	50	Solution	30.28	97526	45689.00	53.15
t500m50r5-1.pl.json	500	50	Solution	30.27	97780	43579.00	55.43
t500m50r5-10.pl.json	500	50	Solution	30.31	97631	41522.00	57.47
t500m50r5-11.pl.json	500	50	Solution	34.24	97571	40447.00	58.55
t500m50r5-12.pl.json	500	50	Solution	30.34	97678	41246.00	57.77
t500m50r5-13.pl.json	500	50	Solution	30.28	97497	37668.00	61.36
t500m50r5-14.pl.json	500	50	Solution	30.29	99505	37897.00	61.91
t500m50r5-15.pl.json	500	50	Solution	30.45	97382	44019.00	54.80
t500m50r5-16.pl.json	500	50	Solution	30.28	97763	41798.00	57.25
t500m50r5-17.pl.json	500	50	Solution	30.32	96938	36155.00	62.70
t500m50r5-18.pl.json	500	50	Solution	30.26	97819	33100.00	66.16

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t500m50r5-19.pl.json	500	50	Solution	34.56	97278	36464.00	62.52
t500m50r5-2.pl.json	500	50	Solution	30.29	96060	40840.00	57.48
t500m50r5-20.pl.json	500	50	Solution	34.18	98245	41452.00	57.81
t500m50r5-3.pl.json	500	50	Solution	30.49	99069	37737.00	61.91
t500m50r5-4.pl.json	500	50	Solution	30.26	98094	33092.00	66.27
t500m50r5-5.pl.json	500	50	Solution	30.35	97837	33529.00	65.73
t500m50r5-6.pl.json	500	50	Solution	30.28	97882	39918.00	59.22
t500m50r5-7.pl.json	500	50	Solution	30.30	97935	41726.00	57.39
t500m50r5-8.pl.json	500	50	Solution	30.28	96977	34249.00	64.68
t500m50r5-9.pl.json	500	50	Solution	30.27	96065	30499.00	68.25
t50m10r10-1.pl.json	50	10	Solution	30.04	6499	5840.00	10.14
t50m10r10-10.pl.json	50	10	Optimal	6.15	3396	3396.00	0.00
t50m10r10-11.pl.json	50	10	Optimal	7.37	3398	3398.00	0.00
t50m10r10-12.pl.json	50	10	Solution	30.04	7550	6544.00	13.32
t50m10r10-13.pl.json	50	10	Optimal	16.73	5484	5484.00	0.00
t50m10r10-14.pl.json	50	10	Solution	30.03	4666	3431.00	26.47
t50m10r10-15.pl.json	50	10	Solution	30.03	6640	5903.00	11.10
t50m10r10-16.pl.json	50	10	Optimal	21.47	4914	4914.00	0.00
t50m10r10-17.pl.json	50	10	Optimal	0.60	2252	2252.00	0.00
t50m10r10-18.pl.json	50	10	Solution	30.04	4034	3841.00	4.78
t50m10r10-19.pl.json	50	10	Solution	30.04	4873	4532.00	7.00
t50m10r10-2.pl.json	50	10	Solution	30.02	4148	3646.00	12.10
t50m10r10-20.pl.json	50	10	Optimal	0.38	3158	3158.00	0.00
t50m10r10-3.pl.json	50	10	Solution	30.04	4334	4190.00	3.32
t50m10r10-4.pl.json	50	10	Solution	30.01	4259	3715.00	12.77
t50m10r10-5.pl.json	50	10	Optimal	5.78	2211	2211.00	0.00
t50m10r10-6.pl.json	50	10	Solution	30.04	5752	5457.00	5.13
t50m10r10-7.pl.json	50	10	Optimal	10.99	3239	3239.00	0.00
t50m10r10-8.pl.json	50	10	Optimal	0.80	2624	2624.00	0.00
t50m10r10-9.pl.json	50	10	Solution	30.02	5109	5015.00	1.84
t50m10r3-1.pl.json	50	10	Optimal	0.54	7067	7067.00	0.00
t50m10r3-10.pl.json	50	10	Optimal	0.35	4504	4504.00	0.00
t50m10r3-11.pl.json	50	10	Solution	30.03	3856	3811.00	1.17
t50m10r3-12.pl.json	50	10	Optimal	0.35	3063	3063.00	0.00
t50m10r3-13.pl.json	50	10	Optimal	0.22	5368	5368.00	0.00
t50m10r3-14.pl.json	50	10	Optimal	0.22	5759	5759.00	0.00
t50m10r3-15.pl.json	50	10	Optimal	1.89	6360	6360.00	0.00
t50m10r3-16.pl.json	50	10	Optimal	0.54	7616	7616.00	0.00
t50m10r3-17.pl.json	50	10	Solution	30.03	5429	5233.00	3.61
t50m10r3-18.pl.json	50	10	Optimal	0.94	5186	5186.00	0.00
t50m10r3-19.pl.json	50	10	Optimal	0.48	4197	4197.00	0.00
t50m10r3-2.pl.json	50	10	Optimal	0.43	5680	5680.00	0.00
t50m10r3-20.pl.json	50	10	Optimal	0.44	7792	7792.00	0.00
t50m10r3-3.pl.json	50	10	Optimal	0.79	3752	3752.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t50m10r3-4.pl.json	50	10	Optimal	0.66	4942	4942.00	0.00
t50m10r3-5.pl.json	50	10	Optimal	0.44	6159	6159.00	0.00
t50m10r3-6.pl.json	50	10	Optimal	0.52	3804	3804.00	0.00
t50m10r3-7.pl.json	50	10	Optimal	0.16	6186	6186.00	0.00
t50m10r3-8.pl.json	50	10	Optimal	0.71	5142	5142.00	0.00
t50m10r3-9.pl.json	50	10	Solution	30.02	7279	7191.00	1.21
t50m10r5-1.pl.json	50	10	Optimal	0.68	5397	5397.00	0.00
t50m10r5-10.pl.json	50	10	Optimal	0.26	4926	4926.00	0.00
t50m10r5-11.pl.json	50	10	Optimal	0.54	3620	3620.00	0.00
t50m10r5-12.pl.json	50	10	Optimal	0.26	5183	5183.00	0.00
t50m10r5-13.pl.json	50	10	Solution	30.03	5716	5394.00	5.63
t50m10r5-14.pl.json	50	10	Optimal	0.60	2828	2828.00	0.00
t50m10r5-15.pl.json	50	10	Solution	30.01	6385	6283.00	1.60
t50m10r5-16.pl.json	50	10	Solution	30.04	4548	3970.00	12.71
t50m10r5-17.pl.json	50	10	Optimal	0.33	5129	5129.00	0.00
t50m10r5-18.pl.json	50	10	Solution	30.02	5831	5303.00	9.06
t50m10r5-19.pl.json	50	10	Solution	30.04	5552	5213.00	6.11
t50m10r5-2.pl.json	50	10	Optimal	0.33	5153	5153.00	0.00
t50m10r5-20.pl.json	50	10	Optimal	9.30	3900	3900.00	0.00
t50m10r5-3.pl.json	50	10	Solution	30.03	4708	4667.00	0.87
t50m10r5-4.pl.json	50	10	Solution	30.02	5551	4986.00	10.18
t50m10r5-5.pl.json	50	10	Optimal	0.31	7451	7451.00	0.00
t50m10r5-6.pl.json	50	10	Optimal	0.53	3781	3781.00	0.00
t50m10r5-7.pl.json	50	10	Optimal	17.68	3323	3323.00	0.00
t50m10r5-8.pl.json	50	10	Solution	30.02	5559	4986.00	10.31
t50m10r5-9.pl.json	50	10	Solution	30.02	6385	6082.00	4.75
t50m20r10-1.pl.json	50	20	Solution	30.04	5211	4457.00	14.47
t50m20r10-10.pl.json	50	20	Optimal	0.59	7934	7934.00	0.00
t50m20r10-11.pl.json	50	20	Optimal	21.37	5509	5509.00	0.00
t50m20r10-12.pl.json	50	20	Solution	30.04	5023	4256.00	15.27
t50m20r10-13.pl.json	50	20	Optimal	0.36	4143	4143.00	0.00
t50m20r10-14.pl.json	50	20	Optimal	0.43	6048	6048.00	0.00
t50m20r10-15.pl.json	50	20	Solution	30.03	5992	5301.00	11.53
t50m20r10-16.pl.json	50	20	Optimal	0.66	5032	5032.00	0.00
t50m20r10-17.pl.json	50	20	Optimal	0.40	4488	4488.00	0.00
t50m20r10-18.pl.json	50	20	Solution	30.02	4848	4599.00	5.14
t50m20r10-19.pl.json	50	20	Solution	30.03	5430	4555.00	16.11
t50m20r10-2.pl.json	50	20	Solution	30.03	6192	5348.00	13.63
t50m20r10-20.pl.json	50	20	Solution	30.03	6271	5680.00	9.42
t50m20r10-3.pl.json	50	20	Solution	30.03	6582	6278.00	4.62
t50m20r10-4.pl.json	50	20	Solution	30.03	5686	5160.00	9.25
t50m20r10-5.pl.json	50	20	Optimal	0.37	3301	3301.00	0.00
t50m20r10-6.pl.json	50	20	Optimal	20.69	4425	4425.00	0.00
t50m20r10-7.pl.json	50	20	Optimal	1.52	3519	3519.00	0.00

Table 7.2: Results for Test Scheduling Problems (CPSat) (840 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
t50m20r10-8.pl.json	50	20	Solution	30.02	4630	4569.00	1.32
t50m20r10-9.pl.json	50	20	Solution	30.05	5869	5303.00	9.64
t50m20r3-1.pl.json	50	20	Optimal	0.26	3869	3869.00	0.00
t50m20r3-10.pl.json	50	20	Optimal	0.33	3982	3982.00	0.00
t50m20r3-11.pl.json	50	20	Optimal	0.38	4144	4144.00	0.00
t50m20r3-12.pl.json	50	20	Optimal	0.39	2791	2791.00	0.00
t50m20r3-13.pl.json	50	20	Optimal	1.02	6449	6449.00	0.00
t50m20r3-14.pl.json	50	20	Optimal	0.36	4933	4933.00	0.00
t50m20r3-15.pl.json	50	20	Optimal	22.87	2436	2436.00	0.00
t50m20r3-16.pl.json	50	20	Optimal	0.19	5872	5872.00	0.00
t50m20r3-17.pl.json	50	20	Optimal	0.54	6880	6880.00	0.00
t50m20r3-18.pl.json	50	20	Optimal	0.32	2811	2811.00	0.00
t50m20r3-19.pl.json	50	20	Optimal	0.44	3465	3465.00	0.00
t50m20r3-2.pl.json	50	20	Optimal	0.38	5570	5570.00	0.00
t50m20r3-20.pl.json	50	20	Optimal	0.44	6364	6364.00	0.00
t50m20r3-3.pl.json	50	20	Optimal	0.51	3081	3081.00	0.00
t50m20r3-4.pl.json	50	20	Optimal	0.43	3505	3505.00	0.00
t50m20r3-5.pl.json	50	20	Optimal	0.44	2228	2228.00	0.00
t50m20r3-6.pl.json	50	20	Optimal	0.82	5713	5713.00	0.00
t50m20r3-7.pl.json	50	20	Optimal	0.74	3173	3173.00	0.00
t50m20r3-8.pl.json	50	20	Optimal	14.05	3908	3908.00	0.00
t50m20r3-9.pl.json	50	20	Optimal	0.44	4661	4661.00	0.00
t50m20r5-1.pl.json	50	20	Solution	30.04	6273	5304.00	15.45
t50m20r5-10.pl.json	50	20	Optimal	0.55	2328	2328.00	0.00
t50m20r5-11.pl.json	50	20	Optimal	1.81	6403	6403.00	0.00
t50m20r5-12.pl.json	50	20	Optimal	1.21	4281	4281.00	0.00
t50m20r5-13.pl.json	50	20	Optimal	0.58	5754	5754.00	0.00
t50m20r5-14.pl.json	50	20	Solution	30.03	6639	5359.00	19.28
t50m20r5-15.pl.json	50	20	Optimal	0.41	3472	3472.00	0.00
t50m20r5-16.pl.json	50	20	Solution	30.04	5934	5042.00	15.03
t50m20r5-17.pl.json	50	20	Optimal	0.28	4745	4745.00	0.00
t50m20r5-18.pl.json	50	20	Optimal	0.31	3147	3147.00	0.00
t50m20r5-19.pl.json	50	20	Optimal	0.65	5960	5960.00	0.00
t50m20r5-2.pl.json	50	20	Solution	30.03	5547	5417.00	2.34
t50m20r5-20.pl.json	50	20	Optimal	0.30	3913	3913.00	0.00
t50m20r5-3.pl.json	50	20	Solution	30.04	5598	4754.00	15.08
t50m20r5-4.pl.json	50	20	Solution	30.03	5367	4465.00	16.81
t50m20r5-5.pl.json	50	20	Optimal	1.74	3648	3648.00	0.00
t50m20r5-6.pl.json	50	20	Optimal	0.38	5449	5449.00	0.00
t50m20r5-7.pl.json	50	20	Solution	30.04	4127	3794.00	8.07
t50m20r5-8.pl.json	50	20	Solution	30.05	5003	4535.00	9.35
t50m20r5-9.pl.json	50	20	Optimal	0.40	4022	4022.00	0.00

Chapter 8

J&J Hybrid Flexible Flowshop with Transportation Times

8.1 Without Transportation Times

8.1.1 Results for CPOptimizer

Table 8.1: Results for Factory Design (CPO) (25 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance20 1.txt	20	80	Optimal	0.60	55	55.00	0.00
instance20 10.txt	20	80	Optimal	0.46	53	53.00	0.00
instance20 11.txt	20	80	Optimal	0.45	61	61.00	0.00
instance20 12.txt	20	80	Optimal	0.48	56	56.00	0.00
instance20 13.txt	20	80	Optimal	0.45	61	61.00	0.00
instance20 14.txt	20	80	Solution	300.06	54	53.00	1.85
instance20 15.txt	20	80	Solution	300.04	49	45.00	8.16
instance20 16.txt	20	80	Optimal	0.42	52	52.00	0.00
instance20 17.txt	20	80	Optimal	0.41	53	53.00	0.00
instance20 18.txt	20	80	Optimal	0.38	56	56.00	0.00
instance20 19.txt	20	80	Optimal	0.44	56	56.00	0.00
instance20 2.txt	20	80	Optimal	0.57	53	53.00	0.00
instance20 20.txt	20	80	Optimal	0.43	55	55.00	0.00
instance20 21.txt	20	80	Optimal	0.46	58	58.00	0.00
instance20 22.txt	20	80	Optimal	10.34	56	56.00	0.00
instance20 23.txt	20	80	Optimal	0.46	47	47.00	0.00
instance20 24.txt	20	80	Optimal	0.47	59	59.00	0.00
instance20 25.txt	20	80	Optimal	0.49	59	59.00	0.00
instance20 3.txt	20	80	Optimal	0.53	51	51.00	0.00
instance20 4.txt	20	80	Solution	300.03	50	49.00	2.00

Table 8.1: Results for Factory Design (CPO) (25 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance20 5.txt	20	80	Solution	300.09	56	55.00	1.79
instance20 6.txt	20	80	Solution	300.06	56	52.00	7.14
instance20 7.txt	20	80	Optimal	0.53	61	61.00	0.00
instance20 8.txt	20	80	Solution	300.07	52	51.00	1.92
instance20 9.txt	20	80	Optimal	0.53	65	65.00	0.00

8.1.2 Results for CPSat

Table 8.2: Results for Factory Design (CPSat) (25 Instances)

Name	Nr Jobs	Nr Machines	Status	Time	Makespan	Bound	Gap Percent
instance20 1.txt	20	80	Optimal	2.47	55	55.00	0.00
instance20 10.txt	20	80	Optimal	2.61	53	53.00	0.00
instance20 11.txt	20	80	Optimal	1.74	61	61.00	0.00
instance20 12.txt	20	80	Optimal	2.48	56	56.00	0.00
instance20 13.txt	20	80	Optimal	1.47	61	61.00	0.00
instance20 14.txt	20	80	Optimal	52.64	54	54.00	0.00
instance20 15.txt	20	80	Optimal	10.57	49	49.00	0.00
instance20 16.txt	20	80	Optimal	2.97	52	52.00	0.00
instance20 17.txt	20	80	Optimal	4.02	53	53.00	0.00
instance20 18.txt	20	80	Optimal	1.89	56	56.00	0.00
instance20 19.txt	20	80	Optimal	2.43	56	56.00	0.00
instance20 2.txt	20	80	Optimal	4.55	53	53.00	0.00
instance20 20.txt	20	80	Optimal	4.03	55	55.00	0.00
instance20 21.txt	20	80	Optimal	2.20	58	58.00	0.00
instance20 22.txt	20	80	Optimal	56.65	56	56.00	0.00
instance20 23.txt	20	80	Optimal	4.08	47	47.00	0.00
instance20 24.txt	20	80	Optimal	2.76	59	59.00	0.00
instance20 25.txt	20	80	Optimal	3.67	59	59.00	0.00
instance20 3.txt	20	80	Optimal	2.44	51	51.00	0.00
instance20 4.txt	20	80	Solution	300.15	50	49.00	2.00
instance20 5.txt	20	80	Optimal	18.43	56	56.00	0.00
instance20 6.txt	20	80	Optimal	42.43	56	56.00	0.00
instance20 7.txt	20	80	Optimal	3.56	61	61.00	0.00
instance20 8.txt	20	80	Optimal	27.78	52	52.00	0.00
instance20 9.txt	20	80	Optimal	3.64	65	65.00	0.00