

Less is more approach: solving degree constraint spanning tree problems

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Abstract. The degree constraint minimum spanning tree (DCMST) stands as one of the fundamental problems in both computer science and combinatorial optimization. In addition, if the goal is to determine the k -subset on which the DCMST is of least cost then the problem is known as the degree constrained k -minimal spanning tree. In this paper, we apply principles of simplicity and change to match and outperform state of the art heuristics on both problems.

Keywords: spanning tree · degree constraint · LIMA · VNS.

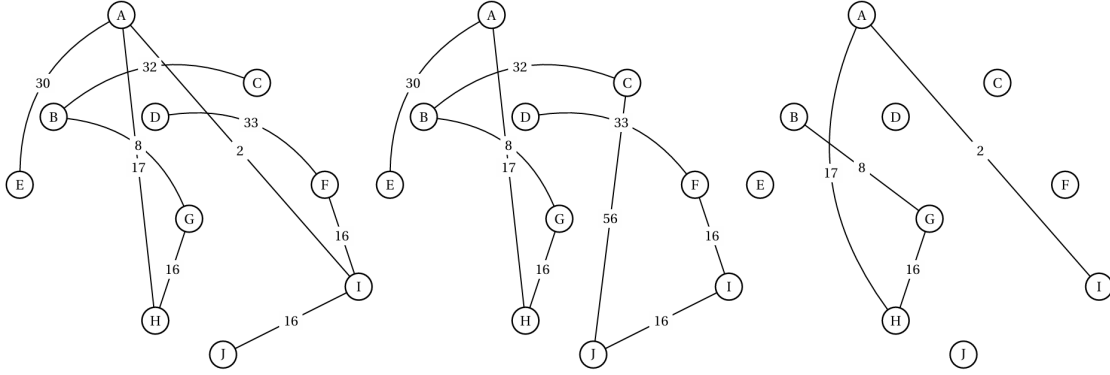


Fig. 1. From left to right: solutions of MST, DCMST where $d = 2$ and DCkMST, where $d = 2$ and $k = 5$ on a complete graph where $n = 10$

1 Computational results and comparison

For a notable results comparison, we took in consideration the current state of the art approaches in [1] and [2]. We conducted the experiment with the model P_2 defined in [1] implemented in Gurobi and ran for 3600s on an Intel® Xeon® E5-1620 v3 CPU on 3.5GHz frequency and 32GB RAM on Windows 10 operating system. The VNS-LIMA metaheuristic was implemented in Java 20 and tested on 16GB RAM, 8-core 4.1GHz AMD Ryzen 2700X machine running on Linux Mint 21.3. The algorithm is single-threaded, but the cores were used for independent parallel execution to speed up the testing phase.

Parts of the code were ported from an online repository¹ project coded in C++, i.e., namely the graph data structure, the TSPLIB parser and Prim's algorithm. The code was then adapted to our needs and improved where possible.

¹ Christofides algorithm

We used all of the TSPLIB instances reported in [1] and all of the instances reported in [2]. Moreover, we introduce additional instances by adding different values of k for the instances from [2]. In total, 444 different instances were tested, and the complete results are reported. We also conducted experiment on another larger instance from TSPLIB. The LP optimal solutions (or upper bounds, if the time limit was exceeded) are compared to the results of running VNS. Since VNS is a randomized search, we run it 10 times per instance, with the time limit of 300 seconds, or stop if the optimal value has been found, whichever comes first.

The following tables present the overall comparison of the VNS results with the LP results from Gurobi, and the results of the cited works for the instances when applicable.

Instance	d	k	LP	ACOR	ACOQ	LIMA
berlin52	2	10	279.23	279.23	279.23	279.23
berlin52	2	20	1015.39	1015.39	1020.02	1015.39
berlin52	2	30	2065.12	2065.12	2069.9	2065.12
berlin52	2	52	6968.77	7156.65	7234.27	6968.77
gr96	2	25	73.56	74.59	74.8	74.59
gr96	2	50	168.53	172.38	180.29	171.14
gr96	2	75	283.14	292.2	302.66	285.86
gr96	2	96	474.94	497.06	534.3	474.95
ch150	2	50	1659.28	1678.93	1722.83	1669.08
ch150	2	80	2795.95	2843.87	2929.44	2868.07
ch150	2	100	3627.93	3788.26	3773.76	3786.12
ch150	2	150	6368.79	6720.31	7005.9	6403.84
# Times optimal			12	3	1	4
# Times best heur.			-	5	2	10

Table 1. Results in comparison with the results on TSPLIB instances from [1] where $d = 2$

Instance	d	k	LP	VNSR	VNSQ	LIMA
berlin52	3	10	274.46	274.46	274.46	274.46
berlin52	3	20	926.77	926.77	926.77	926.77
berlin52	3	30	1935.71	2104.32	2071.97	1935.71
berlin52	3	52	6081.63	6081.63	6081.63	6081.63
gr96	3	25	72.4	79.28	74.14	72.4
gr96	3	50	162.8	179.5	163.7	162.8
gr96	3	75	267.57	269.88	267.57	267.57
gr96	3	96	436.23	436.23	436.23	436.23
ch150	3	50	1567.77	1716.09	1696.06	1567.77
ch150	3	80	2642.04	2792.69	2771.08	2642.04
ch150	3	100	3399.17	3527.7	3499.01	3399.17
ch150	3	150	5882.45	5882.45	5882.45	5882.45
# Times optimal			12	5	6	12
# Times best heur.			-	5	6	12

Table 2. Results in comparison with the results on TSPLIB instances from [1] where $d = 3$

Instance	d	k	LP	HES-EA	ABA	(SSGA)+2ER	(SSGA)+1ER	HSSGA	LIMA
CRD100	2	100	7044	7096	7080	7080	7044	7044	7066
CRD100	3	100	6196	6196	6196	6201	6196	6196	6196
CRD101	2	100	7697	7723	7737	7726	7697	7697	7714
CRD102	2	100	7535	7623	7589	7575	7535	7535	7555
CRD103	2	100	7660	7703	7660	7690	7660	7660	7660
CRD104	2	100	7541	7571	7541	7544	7541	7541	7541
CRD105	2	100	7075	7123	7077	7080	7077	7075	7075
CRD107	2	100	7720	7721	7728	7756	7720	7720	7720
CRD108	2	100	7137	7304	7154	7153	7137	7137	7143
CRD109	2	100	7286	7771	7286	7321	7286	7286	7286
CRD501	2	50	5553	5553	5706	5553	5553	5553	5553
CRD501	3	50	5126	5126	5126	5126	5126	5126	5126
CRD502	2	50	5480	5480	5663	5480	5480	5480	5480
CRD503	2	50	5079	5079	5079	5079	5079	5079	5079
CRD700	2	70	6308	6366	6933	6334	6314	6308	6308
CRD700	3	70	5789	5789	5789	6047	5789	5789	5789
CRD702	2	70	6763	6777	7186	6772	6771	6763	6763
CRD704	2	70	6370	6380	6620	6467	6400	6370	6370
CRD706	2	70	6671	6671	6994	6745	6671	6671	6671
CRD707	2	70	6467	6470	6789	6489	6467	6467	6467
m050n1	5	50	6.6	6.6	6.6	6.68	6.6	6.6	6.6
m050n2	5	50	5.78	5.78	5.78	5.81	5.78	5.78	5.78
m050n3	5	50	5.5	5.5	5.5	5.58	5.5	5.5	5.5
m100n1	5	100	11.08	11.08	11.08	11.47	11.08	11.08	11.08
m100n2	5	100	11.33	11.33	11.33	11.66	11.33	11.33	11.33

Instance	d	k	LP	HES-EA	ABA	(SSGA)+2ER	(SSGA)+1ER	HSSGA	LIMA
m100n3	5	100	10.19	10.19	10.2	10.45	10.19	10.19	10.19
m200n1	5	200	18.33	18.33	18.33	20.48	18.33	18.33	18.35
m200n2	5	200	19.16	19.18	19.19	20.62	19.18	19.16	19.17
m200n3	5	200	16.13	16.13	16.13	17.89	16.13	16.33	16.13
m300n1	5	300	40.68	44.53	40.71	43.48	41.29	40.68	40.7
R100n1	4	100	8.06	8.06	8.06	8.36	8.06	8.06	8.06
R100n1	5	100	7.51	7.51	7.51	7.82	7.51	7.51	7.51
R100n2	4	100	8.06	8.06	8.06	8.34	8.06	8.06	8.06
R100n2	5	100	7.58	7.58	7.58	7.87	7.58	7.58	7.58
R100n3	4	100	8.02	8.02	8.02	8.26	8.02	8.02	8.02
R100n3	5	100	7.5	7.5	7.5	7.78	7.5	7.5	7.5
R200n1	4	200	16.09	16.09	16.09	17.28	16.09	16.09	16.1
R200n1	5	200	15.05	15.05	15.05	16.27	15.05	15.05	15.06
R200n2	4	200	15.69	15.69	15.69	17.06	15.69	15.69	15.69
R200n2	5	200	14.65	14.65	14.65	15.89	14.65	14.65	14.65
R200n3	4	200	15.62	15.63	15.63	16.86	15.62	15.62	15.63
R200n3	5	200	14.59	14.59	14.59	15.95	14.59	14.59	14.6
R50n1	5	50	4.04	4.04	4.04	4.04	4.04	4.04	4.04
R50n2	4	50	4.26	4.26	4.26	4.31	4.26	4.26	4.26
R50n2	5	50	3.94	3.94	3.94	3.99	3.94	3.94	3.94
R50n3	5	50	3.92	3.92	3.92	3.97	3.92	3.92	3.92
SHRD159	2	15	904	904	904	904	904	904	904
SHRD159	3	15	597	597	597	597	597	597	597
SHRD159	4	15	430	430	430	430	430	430	430
SHRD159	5	15	332	332	332	332	332	332	332
SHRD200	2	20	1679	1679	1679	1679	1679	1679	1679
SHRD200	3	20	1088	1088	1088	1088	1088	1088	1088
SHRD200	4	20	802	802	802	802	802	802	802
SHRD200	5	20	627	627	627	627	627	627	627
SHRD259	2	25	2714	2714	2714	2714	2714	2714	2714
SHRD259	3	25	1756	1756	1756	1756	1756	1756	1756
SHRD259	4	25	1292	1292	1292	1292	1292	1292	1292
SHRD259	5	25	1016	1016	1016	1016	1016	1016	1016
SHRD300	2	30	3992	3992	3996	3992	3992	3992	3992
SHRD300	3	30	2592	2592	2592	2592	2592	2592	2592
SHRD300	4	30	1905	1905	1905	1905	1905	1905	1905
SHRD300	5	30	1504	1504	1504	1504	1504	1504	1504
STR1000	2	100	5000	5000	5004	5000	5000	5000	5000
STR1000	3	100	4702	4702	4702	4708	4702	4702	4702
STR1000	4	100	4546	4546	4546	4569	4546	4546	4546
STR1000	5	100	4403	4403	4403	4434	4403	4403	4403
STR1001	2	100	5000	5000	5006	5000	5000	5000	5000
STR1002	2	100	7089	7094	7094	7094	7089	7089	7090
STR1003	2	100	7089	7093	7105	7093	7089	7089	7089
STR1004	2	100	8699	8705	8732	8701	8699	8699	8699
STR1005	2	100	8699	8703	8727	8702	8699	8699	8699
STR1006	2	100	10529	10543	10532	10547	10529	10529	10529
STR1007	2	100	10529	10532	10536	10536	10529	10529	10529
STR1008	2	100	12426	12446	12485	12439	12428	12427	12426
STR1009	2	100	12401	12412	12440	12420	12401	12401	12407
STR500	2	50	4420	4420	4430	4420	4420	4420	4420
STR500	3	50	4118	4118	4118	4118	4118	4118	4118
STR500	4	50	3956	3956	3956	3967	3956	3956	3956
STR500	5	50	3807	3807	3807	3828	3807	3807	3807
STR502	2	50	6126	6126	6159	6126	6126	6126	6126

Instance	d	k	LP	HES-EA	ABA	(SSGA)+2ER	(SSGA)+1ER	HSSGA	LIMA
STR700	2	70	4693	4700	4744	4693	4701	4693	4693
STR700	3	70	4397	4397	4397	4465	4397	4397	4397
STR700	4	70	4245	4245	4245	4341	4245	4245	4245
STR700	5	70	4100	4100	4100	4203	4100	4100	4100
SYM500	2	50	1759	1759	1863	1762	1759	1759	1765
SYM500	3	50	1156	1156	1156	1156	1156	1156	1156
SYM500	4	50	1105	1105	1105	1105	1105	1105	1105
SYM500	5	50	1098	1098	1098	1098	1098	1098	1098
SYM502	2	50	2116	2116	2273	2116	2116	2116	2116
SYM503	2	50	1965	1965	2162	1965	1965	1965	1965
SYM508	2	50	1861	1861	1985	1861	1861	1861	1861
SYM700	2	70	2012	2037	2556	2068	2012	2012	2036
SYM701	2	70	1931	1940	2487	1998	1931	1931	1937
SYM702	2	70	1864	1864	2092	1938	1864	1870	1916
SYM703	2	70	1497	1503	1674	1522	1497	1503	1511
SYM704	2	70	2017	2032	2470	2080	2017	2017	2050
SYM705	2	70	2152	2157	2507	2227	2152	2152	2165
SYM706	2	70	1489	1495	1656	1510	1489	1489	1512
SYM707	2	70	2371	2384	2666	2447	2371	2388	2385
SYM708	2	70	1816	1823	2136	1851	1816	1816	1832
SYM709	2	70	1749	1749	2103	1799	1749	1749	1755
# Times optimal			101	68	56	33	93	96	77
# Times best heur.			-	68	56	33	93	96	77

Table 3: Results in comparison with the instances from [2]

From Table 2 it can be seen that our approach is superior to the VNSR and VNSQ approaches presented in [1], and that it obtains the optimal solutions for all 12 samples with $d = 3$. For $d = 2$ our algorithm is better or equal to the ACO and ACOR approaches in 10 out of 12 test samples, but it obtains the optimal solution only four times (still dominating the other two methods, see Table 1). The other six sub-optimal solutions are in gaps between 0.002% and 4.36%.

Similar results are observed in Table 3. Note that one of the heuristic methods presented in [2] was always optimal. The summary results show that each time our solution is the best, it is also the optimal one. In 77 of 101 instances, our solution matches the optimal one. For many other instances the solution is almost optimal, with difference 1 on the last digit. However, our algorithm dominates in some of the CRD and the majority of the SYM instances when $d = 2$. This is consistent with the results from Table 1, and shows that our approach is not so effective for TSP paths.

We also present a set of completely novel results on the given instances, but with $k < n$, and compare them with the results obtained from the LP model in Appendix A. Table 4 summarizes all the columns of the appendix.

Variable name	Description
min_v	minimum cost value found
min_t	minimum time of the convergence in seconds
avg_v	average cost value over 10 runs
avg_t	average convergence time
mod_v	mode of the cost value over 10 runs
mod_t	mode of the convergence time
med_v	median cost value over 10 runs
med_t	median of the convergence time
lp	minimum cost found using LP
min_d	difference to the minimum costs ($min_v - lp$)
min_g	relative gap of the minimum cost
avg_d	average difference to the minimum cost
avg_g	average gap of the minimum cost
mod_d	mode of the differences to the minimum cost
mod_g	mode of the gaps of the minimum
med_d	median difference to the minimum cost
med_g	median gap of the minimum

Table 4. Summary of columns in the appendix A

The results of the experiment on 444 different instances in total show that our best solution is the same as in LP 305 times. All comparisons are given with the best solutions found using LP model, proven to be optimal in 414 of 428 test cases. For 14 instances, LP exceeds time limit without proof of optimality, and for 16 instances, it is unable to run due to memory limit. The maximal gap in the runs where optimality was not proven was on *STR1004* and *STR1005* with $d = 2$ and $k = 25$, and it was 15.97%, with lower bound 1602, and the final solution 1858. LP results without proof of optimality are shown in Appendix B.

Overall, our approach found optimal solution at least once 71.26% of time, and in 226 cases (52.8%) all ten runs found optimal solution. The majority of ten runs was optimal in 246 (57.48%) test cases. We also present results for the test cases which were not able to be run on LP due to memory limitations, but those were excluded from the statistics as we do not have data for comparison.

References

1. Adasme, P., Dehghan Firoozabadi, A.: Degree-constrained k-minimum spanning tree problem. Complexity **2020**(1), 7628105 (2020)
2. Singh, K., Sundar, S.: A hybrid genetic algorithm for the degree-constrained minimum spanning tree problem. Soft Computing **24**(3), 2169–2186 (2020)

A Appendix: Comparison of the VNS-LIMA and LP Results

9

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
CRD100	2	25	1179	12.306	1179	35.7384	1179	12.306	1179	22.7455	1179	0	0%	0	0%	0	0%	0	0%
CRD100	2	50	2614	6.529	2767.4	123.8849	2814	167.737	2814	130.2685	2607	7	0.26%	160.4	6.15%	207	7.94%	207	7.94%
CRD100	2	75	4654	11.404	4675.5	150.8852	4663	210.845	4667	184.999	4541	113	2.48%	134.5	2.96%	122	2.68%	126	2.77%
CRD100	2	100	7066	26.632	7092	134.9923	7089	295.868	7089	129.988	7044	22	0.31%	48	0.68%	45	0.63%	45	0.63%
CRD100	3	25	1146	0.253	1146	0.3171	1146	0.253	1146	0.3055	1146	0	0%	0	0%	0	0%	0	0%
CRD100	3	50	2512	0.401	2565.1	11.0711	2571	105.001	2571	0.575	2512	0	0%	53.0999	2.11%	59	2.34%	59	2.34%
CRD100	3	75	4112	1.207	4112	4.8219	4112	1.207	4112	4.134	4112	0	0%	0	0%	0	0%	0	0%
CRD100	3	100	6196	0	6196	0.248	6196	0	6196	0.0525	6196	0	0%	0	0%	0	0%	0	0%
CRD101	2	25	1078	0.719	1078	3.3939	1078	0.719	1078	3.2635	1078	0	0%	0	0%	0	0%	0	0%
CRD101	2	50	2719	2.242	2741.5	44.7172	2746	89.253	2745	7.4285	2716	3	0.11%	25.5	0.93%	30	1.1%	29	1.06%
CRD101	2	75	4819	42.714	4879.9	155.1528	4819	179.959	4869.5	144.4164	4815	4	0.08%	64.8999	1.34%	4	0.08%	54.5	1.13%
CRD101	2	100	7714	11.652	7745.6	147.867	7741	21.258	7737.5	142.8775	7697	17	0.22%	48.6	0.63%	44	0.57%	40.5	0.52%
CRD102	2	25	1242	2.131	1242	30.5845	1242	2.131	1242	24.9645	1242	0	0%	0	0%	0	0%	0	0%
CRD102	2	50	3016	14.533	3054.9	93.185	3091	27.949	3048.5	85.0375	2938	78	2.65%	116.9	3.97%	153	5.2%	110.5	3.76%
CRD102	2	75	4917	136.956	4997.5	248.0491	4968	233.796	4978	262.8705	4832	85	1.75%	165.5	3.42%	136	2.81%	146	3.02%
CRD102	2	100	7555	5.968	7616.5	110.4915	7581	7.189	7630	74.4575	7535	20	0.26%	81.5	1.08%	46	0.61%	95	1.26%
CRD103	2	25	1252	1.236	1252	3.23	1252	1.236	1252	2.485	1252	0	0%	0	0%	0	0%	0	0%
CRD103	2	50	2955	16.183	3029.3	118.5898	3002	177.85	3027	110.1305	2955	0	0%	74.3	2.51%	47	1.59%	72	2.43%
CRD103	2	75	4859	15.843	5044.9	211.8018	4859	290.011	5042	239.9895	4859	0	0%	185.8999	3.82%	0	0%	183	3.76%
CRD103	2	100	7660	27.411	7709.9	135.2686	7680	149.601	7702.5	144.704	7660	0	0%	49.8999	0.65%	20	0.26%	42.5	0.55%
CRD104	2	25	1240	0.797	1240	17.6962	1240	0.797	1240	2.2805	1240	0	0%	0	0%	0	0%	0	0%
CRD104	2	50	2986	6.569	2998.2	52.7444	3003	39.196	2998	30.1135	2981	5	0.16%	17.1999	0.57%	22	0.73%	17	0.57%
CRD104	2	75	4973	47.43	5053.7	173.1613	4999	222.885	5014.5	162.615	4924	49	0.99%	129.6999	2.63%	75	1.52%	90.5	1.83%
CRD104	2	100	7541	15.993	7562.1	134.2306	7541	29.571	7557	142.884	7541	0	0%	21.1	0.27%	0	0%	16	0.21%
CRD105	2	25	1197	7.08	1205.4	130.4569	1211	19.471	1211	120.8775	1197	0	0%	8.4	0.7%	14	1.16%	14	1.16%
CRD105	2	50	2918	1.224	2931.6	48.1306	2935	48.94	2935	43.2694	2881	37	1.28%	50.5999	1.75%	54	1.87%	54	1.87%
CRD105	2	75	4714	2.178	4790.5	137.3529	4790	174.776	4793	161.9875	4714	0	0%	76.5	1.62%	76	1.61%	79	1.67%
CRD105	2	100	7075	47.83	7092.7	124.8293	7075	47.83	7077	108.6005	7075	0	0%	17.6999	0.25%	0	0%	2	0.02%
CRD107	2	25	1353	2.501	1353	27.2073	1353	2.501	1353	15.905	1353	0	0%	0	0%	0	0%	0	0%
CRD107	2	50	3152	12.719	3198.2	158.4528	3226	226.771	3190.5	167.471	3152	0	0%	46.1999	1.46%	74	2.34%	38.5	1.22%
CRD107	2	75	5226	32.042	5292.5	172.5572	5226	280.185	5272	167	5172	54	1.04%	120.5	2.32%	54	1.04%	100	1.93%
CRD107	2	100	7720	43.354	7750.3	180.1161	7744	150.312	7748	180.8575	7720	0	0%	30.3	0.39%	24	0.31%	28	0.36%
CRD108	2	25	896	0.192	896	0.5503	896	0.67	896	0.616	896	0	0%	0	0%	0	0%	0	0%
CRD108	2	50	2621	9.532	2626.1	101.0881	2624	83.057	2624	85.1415	2621	0	0%	5.0999	0.19%	3	0.11%	3	0.11%
CRD108	2	75	4623	25.515	4630.1	159.7777	4623	25.515	4627.5	189.5045	4517	106	2.34%	113.1	2.5%	106	2.34%	110.5	2.44%
CRD108	2	100	7143	34.742	7150.7	128.7356	7148	251.107	7148	128.9315	7137	6	0.08%	13.6999	0.19%	11	0.15%	11	0.15%
CRD109	2	25	1305	0.258	1305	2.1416	1305	0.258	1305	1.1945	1305	0	0%	0	0%	0	0%	0	0%
CRD109	2	50	2874	15.301	2882.1	57.7357	2882	25.698	2882	33.5235	2860	14	0.48%	22.0999	0.77%	22	0.76%	22	0.76%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
CRD109	2	75	4585	49.485	4615.2	180.958	4621	293.605	4616	168.637	4574	11	0.24%	41.1999	0.9%	47	1.02%	42	0.91%
CRD109	2	100	7286	18.19	7296.9	157.5547	7293	196.57	7293	170.9814	7286	0	0%	10.8999	0.14%	7	0.09%	7	0.09%
CRD501	2	10	624	0.208	624	0.3247	624	0.208	624	0.3169	624	0	0%	0	0%	0	0%	0	0%
CRD501	2	20	1518	1.642	1518	9.1944	1518	1.642	1518	8.591	1518	0	0%	0	0%	0	0%	0	0%
CRD501	2	30	2547	3.8	2547	102.4518	2547	3.8	2547	119.9885	2547	0	0%	0	0%	0	0%	0	0%
CRD501	2	50	5553	0.705	5553	1.1038	5553	1.096	5553	1.1055	5553	0	0%	0	0%	0	0%	0	0%
CRD501	3	10	624	0.07	624	0.102	624	0.07	624	0.1	624	0	0%	0	0%	0	0%	0	0%
CRD501	3	20	1458	0.689	1458	1.2938	1458	0.689	1458	1.2559	1458	0	0%	0	0%	0	0%	0	0%
CRD501	3	30	2425	0.503	2425	0.9103	2425	0.503	2425	0.95	2425	0	0%	0	0%	0	0%	0	0%
CRD501	3	50	5126	0	5126	0	5126	0	5126	0	5126	0	0%	0	0%	0	0%	0	0%
CRD502	2	10	602	0.09	602	0.1579	602	0.109	602	0.1465	602	0	0%	0	0%	0	0%	0	0%
CRD502	2	20	1496	1.133	1496	2.1842	1496	1.133	1496	2.0215	1496	0	0%	0	0%	0	0%	0	0%
CRD502	2	30	2571	4.634	2581.9	111.0246	2583	204.851	2583	97.1825	2571	0	0%	10.9	0.42%	12	0.46%	12	0.46%
CRD502	2	50	5480	3.36	5481.8	126.6642	5480	43.025	5480	110.9385	5480	0	0%	1.8	0.03%	0	0%	0	0%
CRD503	2	10	566	0.956	566	1.3014	566	0.956	566	1.331	566	0	0%	0	0%	0	0%	0	0%
CRD503	2	20	1379	0.18	1379	0.3307	1379	0.18	1379	0.2895	1379	0	0%	0	0%	0	0%	0	0%
CRD503	2	30	2353	0.551	2353	1.105	2353	0.551	2353	1.141	2353	0	0%	0	0%	0	0%	0	0%
CRD503	2	50	5079	1.321	5079	5.5441	5079	1.321	5079	5.518	5079	0	0%	0	0%	0	0%	0	0%
CRD700	2	20	1232	11.62	1232	54.23	1232	11.62	1232	42.0835	1232	0	0%	0	0%	0	0%	0	0%
CRD700	2	35	2458	4.104	2458	10.5492	2458	4.104	2458	8.4025	2458	0	0%	0	0%	0	0%	0	0%
CRD700	2	50	3657	40.348	3670.7	162.006	3660	189.019	3660	159.4825	3657	0	0%	13.6999	0.37%	3	0.08%	3	0.08%
CRD700	2	70	6308	1.54	6324.2	114.7526	6308	23.017	6308	121.0605	6308	0	0%	16.1999	0.25%	0	0%	0	0%
CRD700	3	20	1170	0.395	1170	0.7471	1170	0.395	1170	0.7335	1170	0	0%	0	0%	0	0%	0	0%
CRD700	3	35	2324	0.176	2324	0.2578	2324	0.249	2324	0.263	2324	0	0%	0	0%	0	0%	0	0%
CRD700	3	50	3504	0.73	3504	0.9092	3504	0.739	3504	0.872	3504	0	0%	0	0%	0	0%	0	0%
CRD700	3	70	5789	0	5789	0	5789	0	5789	0	5789	0	0%	0	0%	0	0%	0	0%
CRD702	2	20	1374	1.033	1374	1.73	1374	1.033	1374	1.5065	1374	0	0%	0	0%	0	0%	0	0%
CRD702	2	35	2721	1.573	2744.1	21.9251	2742	2.687	2742	8.624	2720	1	0.03%	24.0999	0.88%	22	0.8%	22	0.8%
CRD702	2	50	4234	12.988	4264.1	54.7	4266	89.647	4266	30.9325	4234	0	0%	30.1	0.71%	32	0.75%	32	0.75%
CRD702	2	70	6763	4.617	6764.5	105.9102	6764	41.641	6764	92.6835	6763	0	0%	1.5	0.02%	1	0.01%	1	0.01%
CRD704	2	20	1071	0.133	1071	0.4052	1071	0.133	1071	0.419	1071	0	0%	0	0%	0	0%	0	0%
CRD704	2	35	2274	1.889	2274	18.4652	2274	1.889	2274	8.077	2274	0	0%	0	0%	0	0%	0	0%
CRD704	2	50	3588	28.354	3649.6	120.9749	3660	158.873	3660	95.93	3588	0	0%	61.5999	1.71%	72	2%	72	2%
CRD704	2	70	6370	9.541	6396.1	75.749	6370	28.891	6396	56.828	6370	0	0%	26.1	0.4%	0	0%	26	0.4%
CRD706	2	20	1396	0.816	1396	2.4244	1396	0.816	1396	2.1879	1396	0	0%	0	0%	0	0%	0	0%
CRD706	2	35	2689	50.306	2705.3	157.3993	2690	137.647	2698	129.23	2689	0	0%	16.3	0.6%	1	0.03%	9	0.33%
CRD706	2	50	4082	27.716	4098.3	176.0316	4087	130.945	4090.5	183.4334	4082	0	0%	16.3	0.39%	5	0.12%	8.5	0.2%
CRD706	2	70	6671	10.765	6686.1	95.576	6671	16.508	6685.5	45.0395	6671	0	0%	15.1	0.22%	0	0%	14.5	0.21%
CRD707	2	20	1238	0.541	1238	1.0514	1238	0.541	1238	0.963	1238	0	0%	0	0%	0	0%	0	0%
CRD707	2	35	2393	1.28	2395.7	50.7887	2393	22.731	2393	37.3915	2393	0	0%	2.6999	0.11%	0	0%	0	0%
CRD707	2	50	3831	20.188	3904	161.9027	3932	139.321	3929	119.7034	3831	0	0%	73	1.9%	101	2.63%	98	2.55%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
CRD707	2	70	6467	14.494	6477.2	101.6212	6484	14.494	6484	84.959	6467	0	0%	10.1999	0.15%	17	0.26%	17	0.26%
m050n1	5	10	0.181	0.06	0.181	0.0743	0.181	0.06	0.181	0.072	0.181	0	0%	0	0%	0	0%	0	0%
m050n1	5	20	0.558	0.096	0.558	0.1517	0.558	0.096	0.558	0.128	0.558	0	0%	0	0%	0	0%	0	0%
m050n1	5	30	1.142	0.213	1.142	0.3801	1.142	0.213	1.142	0.4054	1.142	0	0%	0	0%	0	0%	0	0%
m050n1	5	50	6.601	0.416	6.601	1.8711	6.601	0.416	6.601	1.9805	6.601	0	0%	0	0%	0	0%	0	0%
m050n2	5	10	0.244	0.075	0.244	0.2293	0.244	0.085	0.244	0.2455	0.244	0	0%	0	0%	0	0%	0	0%
m050n2	5	20	0.565	0.105	0.565	0.1745	0.565	0.105	0.565	0.183	0.565	0	0%	0	0%	0	0%	0	0%
m050n2	5	30	1.068	0.204	1.068	0.2683	1.068	0.302	1.068	0.2755	1.068	0	0%	0	0%	0	0%	0	0%
m050n2	5	50	5.7765	0.726	5.7765	7.0984	5.7765	0.726	5.7765	7.093	5.7765	0	0%	0	0%	0	0%	0	0%
m050n3	5	10	0.16	0.675	0.16	1.4541	0.16	0.675	0.16	1.3895	0.16	0	0%	0	0%	0	0%	0	0%
m050n3	5	20	0.563	0.106	0.563	0.4987	0.563	0.106	0.563	0.562	0.563	0	0%	0	0%	0	0%	0	0%
m050n3	5	30	1.046	0.154	1.046	1.2114	1.046	0.154	1.046	1.2045	1.046	0	0%	0	0%	0	0%	0	0%
m050n3	5	50	5.502	1.125	5.502	2.8021	5.502	1.125	5.502	2.9755	5.502	0	0%	0	0%	0	0%	0	0%
m100n1	5	25	0.742	0.421	0.742	2.4236	0.742	0.427	0.742	2.381	0.742	0	0%	0	0%	0	0%	0	0%
m100n1	5	50	1.8835	0.624	1.8835	29.9637	1.8835	0.624	1.8835	20.9384	1.8835	0	0%	0	0%	0	0%	0	0%
m100n1	5	75	5.4495	1.452	5.4495	10.2857	5.4495	1.452	5.4495	5.9855	5.4495	0	0%	0	0%	0	0%	0	0%
m100n1	5	100	11.0825	1.998	11.0825	31.4221	11.0825	1.998	11.0825	19.043	11.0825	0	0%	0	0%	0	0%	0	0%
m100n2	5	25	0.668	0.322	0.668	0.3375	0.668	0.355	0.668	0.3385	0.668	0	0%	0	0%	0	0%	0	0%
m100n2	5	50	1.719	0.652	1.719	1.0454	1.719	0.675	1.719	0.8494	1.719	0	0%	0	0%	0	0%	0	0%
m100n2	5	75	5.318	2.782	5.318	4.2299	5.318	2.782	5.318	3.526	5.318	0	0%	0	0%	0	0%	0	0%
m100n2	5	100	11.33	2.105	11.33	50.4458	11.33	2.105	11.33	41.6825	11.33	0	0%	0	0%	0	0%	0	0%
m100n3	5	25	0.674	0.44	0.674	1.0355	0.674	0.44	0.674	1.078	0.674	0	0%	0	0%	0	0%	0	0%
m100n3	5	50	1.618	0.296	1.618	0.6176	1.618	0.296	1.618	0.5325	1.618	0	0%	0	0%	0	0%	0	0%
m100n3	5	75	4.2505	0.673	4.2505	1.0917	4.2505	0.673	4.2505	1.131	4.2505	0	0%	0	0%	0	0%	0	0%
m100n3	5	100	10.192	10.853	10.192	62.4641	10.192	10.853	10.192	59.9634	10.192	0	0%	0	0%	0	0%	0	0%
m200n1	5	50	1.499	0.743	1.499	23.9084	1.499	0.743	1.499	13.1455	1.499	0	0%	0	0%	0	0%	0	0%
m200n1	5	100	3.532	2.483	3.5847	76.4333	3.532	2.483	3.603	49.9625	3.532	0	0%	0.0527	1.49%	0	0%	0.071	2.01%
m200n1	5	150	7.831	4.466	7.8342	125.6927	7.833	66.296	7.833	116.334	7.831	0	0%	0.0031	0.04%	0.0019	0.02%	0.0019	0.02%
m200n1	5	200	18.3485	6.795	18.3854	134.4172	18.4035	169.516	18.3815	168.3355	18.3345	0.014	0.07%	0.0509	0.27%	0.069	0.37%	0.047	0.25%
m200n2	5	50	1.666	19.835	1.668	124.0819	1.666	82.136	1.666	102.809	1.666	0	0%	0.002	0.12%	0	0%	0	0%
m200n2	5	100	3.79	96.711	3.8053	175.401	3.79	96.711	3.801	156.47	3.79	0	0%	0.0152	0.4%	0	0%	0.011	0.29%
m200n2	5	150	8.18	12.769	8.1853	132.9833	8.1855	199.632	8.1855	122.3225	8.18	0	0%	0.0053	0.06%	0.0054	0.06%	0.0054	0.06%
m200n2	5	200	19.166	12.814	19.188	171.0457	19.242	156.241	19.1765	176.0185	19.16	0.006	0.03%	0.0279	0.14%	0.082	0.42%	0.0165	0.08%
m200n3	5	50	1.395	1.907	1.4062	74.8274	1.409	87.942	1.409	39.854	1.395	0	0%	0.0112	0.8%	0.014	1%	0.014	1%
m200n3	5	100	3.314	16.422	3.314	91.5846	3.314	16.422	3.314	95.859	3.314	0	0%	0	0%	0	0%	0	0%
m200n3	5	150	6.103	7.284	6.1429	98.991	6.103	28.058	6.153	77.138	6.103	0	0%	0.0399	0.65%	0	0%	0.0499	0.81%
m200n3	5	200	16.1345	96.666	16.1562	175.0174	16.1575	224.427	16.1575	170.9694	16.1255	0.009	0.05%	0.0307	0.19%	0.032	0.19%	0.032	0.19%
m300n1	5	75	2.2027	24.817	2.291	130.2027	2.2424	35.562	2.3061	110.935	2.1598	0.0428	1.98%	0.1311	6.07%	0.0825	3.82%	0.1462	6.77%
m300n1	5	150	8.8586	24.171	8.8994	182.959	8.9131	211.11	8.9079	216.818	8.7933	0.0653	0.74%	0.1061	1.2%	0.1197	1.36%	0.1146	1.3%
m300n1	5	225	23.9375	21.577	23.9769	32.7562	23.9741	33.204	23.9771	31.415	23.9247	0.0128	0.05%	0.0522	0.21%	0.0494	0.2%	0.0524	0.21%
m300n1	5	300	40.6967	32.283	40.7742	57.9716	40.6967	129.761	40.775	46.7805	40.6799	0.0168	0.04%	0.0943	0.23%	0.0168	0.04%	0.0951	0.23%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
m400n1	5	100	2.815	5.726	2.8687	139.889	2.815	172.519	2.8241	146.749	-	-	-	-	-	-	-	-	-
m400n1	5	200	10.333	32.769	10.4315	83.1541	10.4817	69.273	10.4481	69.0519	-	-	-	-	-	-	-	-	-
m400n1	5	300	30.4037	41.668	30.4978	81.1371	30.4037	98.045	30.4922	76.4275	-	-	-	-	-	-	-	-	-
m400n1	5	400	54.6648	103.152	54.7784	194.4784	54.8705	298.236	54.7715	183.927	-	-	-	-	-	-	-	-	-
m500n1	5	125	3.2677	7.705	3.3762	114.2572	3.3284	103.806	3.3786	105.2895	-	-	-	-	-	-	-	-	-
m500n1	5	250	19.7366	52.568	19.7703	94.9136	19.751	90.105	19.7731	85.465	-	-	-	-	-	-	-	-	-
m500n1	5	375	45.0251	182.771	45.119	250.1765	45.111	257.185	45.1137	258.3485	-	-	-	-	-	-	-	-	-
m500n1	5	500	79.3774	225.241	79.525	281.1361	79.6177	298.823	79.4587	294.624	-	-	-	-	-	-	-	-	-
R100n1	4	25	0.667	12.72	0.6683	97.4703	0.667	120.637	0.667	94.5955	0.664	0.003	0.45%	0.0042	0.64%	0.003	0.45%	0.003	0.45%
R100n1	4	50	2.229	30.494	2.2391	137.6209	2.24	178.173	2.24	143.782	2.217	0.012	0.54%	0.0221	0.99%	0.023	1.03%	0.023	1.03%
R100n1	4	75	4.939	5.331	4.939	16.7647	4.939	5.331	4.939	13.5305	4.939	0	0%	0	0%	0	0%	0	0%
R100n1	4	100	8.057	1.876	8.057	38.988	8.057	1.876	8.057	32.254	8.057	0	0%	0	0%	0	0%	0	0%
R100n1	5	25	0.589	1.287	0.589	1.948	0.589	1.287	0.589	1.751	0.589	0	0%	0	0%	0	0%	0	0%
R100n1	5	50	1.793	20	1.7977	86.8879	1.798	20	1.798	50.169	1.793	0	0%	0.0047	0.26%	0.005	0.27%	0.005	0.27%
R100n1	5	75	4.407	1.663	4.407	48.7643	4.407	1.663	4.407	20.1854	4.407	0	0%	0	0%	0	0%	0	0%
R100n1	5	100	7.51	2.138	7.51	28.613	7.51	2.138	7.51	27.162	7.51	0	0%	0	0%	0	0%	0	0%
R100n2	4	25	0.611	1.3	0.611	1.9887	0.611	1.3	0.611	1.811	0.611	0	0%	0	0%	0	0%	0	0%
R100n2	4	50	2.265	18.994	2.2959	126.6671	2.2889	211.145	2.2889	137.735	2.228	0.0369	1.66%	0.0678	3.04%	0.0599	2.69%	0.0609	2.73%
R100n2	4	75	4.964	16.268	4.9679	95.5113	4.964	112.806	4.964	86.56	4.963	0.001	0.02%	0.0049	0.09%	0.001	0.02%	0.001	0.02%
R100n2	4	100	8.057	11.758	8.057	51.626	8.057	11.758	8.057	36.5434	8.057	0	0%	0	0%	0	0%	0	0%
R100n2	5	25	0.574	0.772	0.574	1.6902	0.574	0.772	0.574	1.5305	0.574	0	0%	0	0%	0	0%	0	0%
R100n2	5	50	1.861	8.988	1.8754	131.5436	1.861	100.649	1.882	117.5615	1.86	0.0009	0.05%	0.0153	0.82%	0.0009	0.05%	0.0219	1.18%
R100n2	5	75	4.494	3.565	4.497	65.7271	4.494	3.565	4.497	19.5565	4.494	0	0%	0.003	0.06%	0	0%	0.003	0.06%
R100n2	5	100	7.579	3.393	7.5793	113.8676	7.579	3.393	7.579	98.076	7.579	0	0%	0.0003	0%	0	0%	0	0%
R100n3	4	25	0.622	9.558	0.622	110.0043	0.622	9.558	0.622	107.977	0.622	0	0%	0	0%	0	0%	0	0%
R100n3	4	50	2.281	18.76	2.2819	60.2314	2.282	66.627	2.282	52.599	2.263	0.018	0.79%	0.0189	0.83%	0.019	0.83%	0.019	0.83%
R100n3	4	75	4.988	6.623	4.9882	40.6336	4.988	6.623	4.988	22.1285	4.988	0	0%	0.0002	0%	0	0%	0	0%
R100n3	4	100	8.017	1.747	8.017	23.2124	8.017	1.747	8.017	21.415	8.017	0	0%	0	0%	0	0%	0	0%
R100n3	5	25	0.545	0.908	0.545	2.5467	0.545	0.908	0.545	2.4985	0.545	0	0%	0	0%	0	0%	0	0%
R100n3	5	50	1.865	6.843	1.865	25.2557	1.865	6.843	1.865	22.2045	1.865	0	0%	0	0%	0	0%	0	0%
R100n3	5	75	4.493	1.995	4.493	21.0822	4.493	1.995	4.493	11.4385	4.493	0	0%	0	0%	0	0%	0	0%
R100n3	5	100	7.5	15.068	7.5	43.8499	7.5	15.068	7.5	37.7965	7.5	0	0%	0	0%	0	0%	0	0%
R200n1	4	50	1.428	12.057	1.4667	138.3708	1.467	211.021	1.467	123.4429	1.399	0.0289	2.07%	0.0677	4.83%	0.068	4.86%	0.068	4.86%
R200n1	4	100	4.73	24.331	4.7537	154.757	4.749	24.331	4.749	151.2	4.656	0.074	1.58%	0.0977	2.09%	0.0929	1.99%	0.0929	1.99%
R200n1	4	150	10.203	5.92	10.2377	185.727	10.203	128.151	10.238	186.242	10.201	0.0019	0.01%	0.0366	0.35%	0.0019	0.01%	0.0369	0.36%
R200n1	4	200	16.103	159.967	16.1206	180.5367	16.117	159.967	16.117	182.487	16.093	0.01	0.06%	0.0275	0.17%	0.024	0.14%	0.024	0.14%
R200n1	5	50	1.317	45.824	1.3289	121.46	1.333	158.069	1.327	96.951	1.294	0.0229	1.77%	0.0348	2.69%	0.0389	3.01%	0.0329	2.55%
R200n1	5	100	3.843	46.412	3.8663	144.2349	3.884	184.287	3.865	114.775	3.834	0.0089	0.23%	0.0322	0.84%	0.0499	1.3%	0.031	0.8%
R200n1	5	150	9.197	51.45	9.2645	212.1593	9.292	275.423	9.2915	232.1025	9.191	0.0059	0.06%	0.0734	0.79%	0.1009	1.09%	0.1004	1.09%
R200n1	5	200	15.065	7.903	15.0868	173.8285	15.082	215.757	15.081	211.3815	15.05	0.0149	0.09%	0.0367	0.24%	0.032	0.21%	0.0309	0.2%
R200n2	4	50	1.267	14.483	1.2672	53.7059	1.267	14.483	1.267	53.5265	1.267	0	0%	0.0002	0.02%	0	0%	0	0%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
R200n2	4	100	4.439	58.235	4.4833	193.0617	4.5	196.06	4.491	209.851	4.289	0.15	3.49%	0.1943	4.53%	0.211	4.91%	0.2019	4.7%
R200n2	4	150	9.808	13.645	9.8611	177.3478	9.885	220.601	9.8705	203.5085	9.789	0.019	0.19%	0.0721	0.73%	0.096	0.98%	0.0815	0.83%
R200n2	4	200	15.692	10.543	15.7333	127.5784	15.696	16.686	15.7345	190.7785	15.688	0.0039	0.02%	0.0452	0.28%	0.0079	0.05%	0.0464	0.29%
R200n2	5	50	1.21	16.912	1.21	102.8023	1.21	76.088	1.21	96.513	1.208	0.002	0.16%	0.002	0.16%	0.002	0.16%	0.002	0.16%
R200n2	5	100	3.692	27.263	3.7252	136.1505	3.731	289.208	3.731	95.5345	3.575	0.1169	3.27%	0.1501	4.2%	0.1559	4.36%	0.1559	4.36%
R200n2	5	150	8.861	10.494	8.8798	122.4834	8.861	235.799	8.8735	85.7355	8.801	0.06	0.68%	0.0787	0.89%	0.06	0.68%	0.0724	0.82%
R200n2	5	200	14.651	11.381	14.6815	153.2609	14.68	11.381	14.678	195.538	14.65	0.0009	0%	0.0314	0.21%	0.0299	0.2%	0.028	0.19%
R200n3	4	50	1.278	6.64	1.2798	56.7748	1.28	126.94	1.28	41.805	1.276	0.002	0.15%	0.0038	0.29%	0.004	0.31%	0.004	0.31%
R200n3	4	100	4.356	55.968	4.4028	181.0086	4.446	151.916	4.4	188.8034	4.26	0.096	2.25%	0.1428	3.35%	0.1859	4.36%	0.14	3.28%
R200n3	4	150	9.72	6.966	9.7446	135.1841	9.72	6.966	9.7295	137.0335	9.717	0.003	0.03%	0.0275	0.28%	0.003	0.03%	0.0124	0.12%
R200n3	4	200	15.633	8.054	15.6512	167.2594	15.64	252.776	15.6435	193.6615	15.625	0.0079	0.05%	0.0262	0.16%	0.015	0.09%	0.0184	0.11%
R200n3	5	50	1.196	7.359	1.196	41.3195	1.196	7.359	1.196	36.891	1.196	0	0%	0	0%	0	0%	0	0%
R200n3	5	100	3.546	33.009	3.5743	181.4401	3.55	90.138	3.574	217.0305	3.49	0.0559	1.6%	0.0842	2.41%	0.0599	1.71%	0.0839	2.4%
R200n3	5	150	8.713	11.115	8.7422	147.0589	8.742	153.886	8.7425	148.213	8.7	0.0129	0.14%	0.0422	0.48%	0.042	0.48%	0.0425	0.48%
R200n3	5	200	14.597	11.892	14.6195	162.9812	14.651	215.551	14.615	196.0025	14.586	0.0109	0.07%	0.0335	0.22%	0.0649	0.44%	0.0289	0.19%
R50n1	5	10	0.204	0.08	0.204	0.109	0.204	0.08	0.204	0.104	0.204	0	0%	0	0%	0	0%	0	0%
R50n1	5	20	0.604	0.292	0.604	0.7013	0.604	0.292	0.604	0.6619	0.604	0	0%	0	0%	0	0%	0	0%
R50n1	5	30	1.531	0.28	1.531	0.37	1.531	0.389	1.531	0.377	1.531	0	0%	0	0%	0	0%	0	0%
R50n1	5	50	4.037	0.506	4.037	1.1284	4.037	0.506	4.037	1.08	4.037	0	0%	0	0%	0	0%	0	0%
R50n2	4	10	0.178	0.078	0.178	0.0911	0.178	0.098	0.178	0.092	0.178	0	0%	0	0%	0	0%	0	0%
R50n2	4	20	0.661	0.155	0.661	0.2343	0.661	0.155	0.661	0.2334	0.661	0	0%	0	0%	0	0%	0	0%
R50n2	4	30	1.641	0.471	1.641	0.7106	1.641	0.779	1.641	0.773	1.641	0	0%	0	0%	0	0%	0	0%
R50n2	4	50	4.26	0.602	4.26	1.0272	4.26	0.602	4.26	0.975	4.26	0	0%	0	0%	0	0%	0	0%
R50n2	5	10	0.176	0.068	0.176	0.0853	0.176	0.084	0.176	0.089	0.176	0	0%	0	0%	0	0%	0	0%
R50n2	5	20	0.542	0.206	0.542	0.2384	0.542	0.233	0.542	0.2345	0.542	0	0%	0	0%	0	0%	0	0%
R50n2	5	30	1.37	0.518	1.37	0.661	1.37	0.518	1.37	0.669	1.37	0	0%	0	0%	0	0%	0	0%
R50n2	5	50	3.938	0.635	3.938	1.0893	3.938	0.635	3.938	1.0135	3.938	0	0%	0	0%	0	0%	0	0%
R50n3	5	10	0.162	0.067	0.162	0.0925	0.162	0.079	0.162	0.0965	0.162	0	0%	0	0%	0	0%	0	0%
R50n3	5	20	0.445	0.16	0.445	0.2406	0.445	0.223	0.445	0.2305	0.445	0	0%	0	0%	0	0%	0	0%
R50n3	5	30	1.229	0.447	1.229	0.997	1.229	0.447	1.229	1.144	1.229	0	0%	0	0%	0	0%	0	0%
R50n3	5	50	3.923	1.795	3.923	2.9361	3.923	1.795	3.923	3.0055	3.923	0	0%	0	0%	0	0%	0	0%
SHRD159	2	4	28	0.03	28	0.0341	28	0.034	28	0.034	28	0	0%	0	0%	0	0%	0	0%
SHRD159	2	8	201	0.052	201	0.0644	201	0.062	201	0.062	201	0	0%	0	0%	0	0%	0	0%
SHRD159	2	12	546	0.05	546	0.0664	546	0.073	546	0.0665	546	0	0%	0	0%	0	0%	0	0%
SHRD159	2	15	904	0.094	904	0.1505	904	0.094	904	0.1655	904	0	0%	0	0%	0	0%	0	0%
SHRD159	3	4	5	0.028	5	0.0302	5	0.032	5	0.03	5	0	0%	0	0%	0	0%	0	0%
SHRD159	3	8	122	0.029	122	0.0406	122	0.041	122	0.0405	122	0	0%	0	0%	0	0%	0	0%
SHRD159	3	12	343	0.042	343	0.053	343	0.046	343	0.0525	343	0	0%	0	0%	0	0%	0	0%
SHRD159	3	15	597	0.067	597	0.0826	597	0.075	597	0.0824	597	0	0%	0	0%	0	0%	0	0%
SHRD159	4	4	5	0.026	5	0.0288	5	0.029	5	0.029	5	0	0%	0	0%	0	0%	0	0%
SHRD159	4	8	83	0.031	83	0.0412	83	0.041	83	0.0405	83	0	0%	0	0%	0	0%	0	0%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
SHRD159	4	12	243	0.037	243	0.0487	243	0.044	243	0.046	243	0	0%	0	0%	0	0%	0	0%
SHRD159	4	15	430	0.049	430	0.0558	430	0.051	430	0.0525	430	0	0%	0	0%	0	0%	0	0%
SHRD159	5	4	5	0.028	5	0.0312	5	0.029	5	0.0305	5	0	0%	0	0%	0	0%	0	0%
SHRD159	5	8	60	0.035	60	0.0439	60	0.039	60	0.0435	60	0	0%	0	0%	0	0%	0	0%
SHRD159	5	12	184	0.047	184	0.0521	184	0.055	184	0.0525	184	0	0%	0	0%	0	0%	0	0%
SHRD159	5	15	332	0.043	332	0.0496	332	0.051	332	0.051	332	0	0%	0	0%	0	0%	0	0%
SHRD200	2	5	52	0	52	0.13	52	0.041	52	0.1205	52	0	0%	0	0%	0	0%	0	0%
SHRD200	2	10	345	0.115	345	0.2262	345	0.126	345	0.2175	345	0	0%	0	0%	0	0%	0	0%
SHRD200	2	15	873	0.098	873	0.1445	873	0.101	873	0.137	873	0	0%	0	0%	0	0%	0	0%
SHRD200	2	20	1679	0.084	1679	0.202	1679	0.084	1679	0.2175	1679	0	0%	0	0%	0	0%	0	0%
SHRD200	3	5	30	0.033	30	0.0394	30	0.044	30	0.0385	30	0	0%	0	0%	0	0%	0	0%
SHRD200	3	10	205	0.049	205	0.0542	205	0.052	205	0.055	205	0	0%	0	0%	0	0%	0	0%
SHRD200	3	15	562	0.062	562	0.107	562	0.062	562	0.1075	562	0	0%	0	0%	0	0%	0	0%
SHRD200	3	20	1088	0.103	1088	0.5064	1088	0.103	1088	0.5115	1088	0	0%	0	0%	0	0%	0	0%
SHRD200	4	5	7	0.036	7	0.0385	7	0.038	7	0.0385	7	0	0%	0	0%	0	0%	0	0%
SHRD200	4	10	148	0.046	148	0.0556	148	0.053	148	0.0555	148	0	0%	0	0%	0	0%	0	0%
SHRD200	4	15	405	0.054	405	0.0802	405	0.054	405	0.083	405	0	0%	0	0%	0	0%	0	0%
SHRD200	4	20	802	0.075	802	0.1814	802	0.236	802	0.194	802	0	0%	0	0%	0	0%	0	0%
SHRD200	5	5	7	0.037	7	0.0414	7	0.041	7	0.0415	7	0	0%	0	0%	0	0%	0	0%
SHRD200	5	10	109	0.047	109	0.0536	109	0.058	109	0.054	109	0	0%	0	0%	0	0%	0	0%
SHRD200	5	15	308	0.076	308	0.1302	308	0.08	308	0.137	308	0	0%	0	0%	0	0%	0	0%
SHRD200	5	20	627	0.066	627	0.1158	627	0.066	627	0.107	627	0	0%	0	0%	0	0%	0	0%
SHRD259	2	6	96	0.051	96	0.0628	96	0.06	96	0.062	96	0	0%	0	0%	0	0%	0	0%
SHRD259	2	13	631	0.135	631	0.4219	631	0.138	631	0.385	631	0	0%	0	0%	0	0%	0	0%
SHRD259	2	18	1324	1.109	1324	1.9131	1324	1.109	1324	1.639	1324	0	0%	0	0%	0	0%	0	0%
SHRD259	2	25	2714	0.095	2714	0.5528	2714	0.095	2714	0.6665	2714	0	0%	0	0%	0	0%	0	0%
SHRD259	3	6	56	0.048	56	0.0553	56	0.048	56	0.0565	56	0	0%	0	0%	0	0%	0	0%
SHRD259	3	13	389	0.045	389	0.0684	389	0.071	389	0.0725	389	0	0%	0	0%	0	0%	0	0%
SHRD259	3	18	846	0.104	846	0.2215	846	0.104	846	0.2334	846	0	0%	0	0%	0	0%	0	0%
SHRD259	3	25	1756	0.359	1756	0.6475	1756	0.359	1756	0.5925	1756	0	0%	0	0%	0	0%	0	0%
SHRD259	4	6	38	0.041	38	0.0497	38	0.05	38	0.05	38	0	0%	0	0%	0	0%	0	0%
SHRD259	4	13	272	0.054	272	0.0653	272	0.063	272	0.0655	272	0	0%	0	0%	0	0%	0	0%
SHRD259	4	18	609	0.053	609	0.0758	609	0.064	609	0.0735	609	0	0%	0	0%	0	0%	0	0%
SHRD259	4	25	1292	0.157	1292	0.8149	1292	0.157	1292	0.9079	1292	0	0%	0	0%	0	0%	0	0%
SHRD259	5	6	16	0.045	16	0.0496	16	0.051	16	0.05	16	0	0%	0	0%	0	0%	0	0%
SHRD259	5	13	218	0.073	218	0.0818	218	0.086	218	0.0815	218	0	0%	0	0%	0	0%	0	0%
SHRD259	5	18	472	0.053	472	0.1077	472	0.053	472	0.099	472	0	0%	0	0%	0	0%	0	0%
SHRD259	5	25	1016	0.146	1016	0.2537	1016	0.161	1016	0.2269	1016	0	0%	0	0%	0	0%	0	0%
SHRD300	2	7	135	0.088	135	0.2266	135	0.088	135	0.2289	135	0	0%	0	0%	0	0%	0	0%
SHRD300	2	15	867	0.246	867	0.7825	867	0.246	867	0.838	867	0	0%	0	0%	0	0%	0	0%
SHRD300	2	22	2044	0.798	2044.1	36.4239	2044	1.673	2044	9.541	2044	0	0%	0.0999	0%	0	0%	0	0%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
SHRD300	2	30	3992	1.319	3992	2.6972	3992	1.319	3992	1.826	3992	0	0%	0	0%	0	0%	0	0%
SHRD300	3	7	78	0.066	78	0.0711	78	0.076	78	0.0705	78	0	0%	0	0%	0	0%	0	0%
SHRD300	3	15	551	0.097	551	0.1958	551	0.097	551	0.212	551	0	0%	0	0%	0	0%	0	0%
SHRD300	3	22	1306	0.198	1306	0.3757	1306	0.198	1306	0.3815	1306	0	0%	0	0%	0	0%	0	0%
SHRD300	3	30	2592	1.993	2592	27.5642	2592	1.993	2592	13.82	2592	0	0%	0	0%	0	0%	0	0%
SHRD300	4	7	59	0.059	59	0.0723	59	0.06	59	0.0645	59	0	0%	0	0%	0	0%	0	0%
SHRD300	4	15	396	0.058	396	0.0713	396	0.077	396	0.072	396	0	0%	0	0%	0	0%	0	0%
SHRD300	4	22	955	0.207	955	0.4785	955	0.207	955	0.4954	955	0	0%	0	0%	0	0%	0	0%
SHRD300	4	30	1905	0.162	1905	0.4757	1905	0.162	1905	0.4875	1905	0	0%	0	0%	0	0%	0	0%
SHRD300	5	7	41	0.049	41	0.0591	41	0.062	41	0.0579	41	0	0%	0	0%	0	0%	0	0%
SHRD300	5	15	300	0.055	300	0.081	300	0.087	300	0.0854	300	0	0%	0	0%	0	0%	0	0%
SHRD300	5	22	743	0.098	743	0.195	743	0.111	743	0.214	743	0	0%	0	0%	0	0%	0	0%
SHRD300	5	30	1504	0.16	1504	0.3205	1504	0.16	1504	0.318	1504	0	0%	0	0%	0	0%	0	0%
STR1000	2	25	947	1.102	950.1	45.4651	950	77.035	950	17.6135	947	0	0%	3.1	0.32%	3	0.31%	3	0.31%
STR1000	2	50	2023	2.708	2023	19.3602	2023	2.708	2023	11.7895	2023	0	0%	0	0%	0	0%	0	0%
STR1000	2	75	3641	61.611	3654.1	198.3279	3651	61.611	3651.5	206.2674	3639	2	0.05%	15.0999	0.41%	12	0.32%	12.5	0.34%
STR1000	2	100	5000	12.003	5005.8	157.6016	5000	12.003	5007	147.4195	5000	0	0%	5.8	0.11%	0	0%	7	0.14%
STR1000	3	25	1217	1.258	1217	22.2497	1217	43.921	1217	20.618	937	280	29.88%	280	29.88%	280	29.88%	280	29.88%
STR1000	3	50	1989	13.31	1989	51.3097	1989	106.593	1989	39.4629	1977	12	0.6%	12	0.6%	12	0.6%	12	0.6%
STR1000	3	75	3579	32.184	3583.8	132.3801	3579	173.195	3579	112.4619	3579	0	0%	4.8	0.13%	0	0%	0	0%
STR1000	3	100	4702	1.509	4702	11.7348	4702	1.509	4702	3.981	4702	0	0%	0	0%	0	0%	0	0%
STR1000	4	25	1217	6.709	1217	53.4162	1217	51.608	1217	43.3354	935	282	30.16%	282	30.16%	282	30.16%	282	30.16%
STR1000	4	50	2071	0.574	2071	0.7837	2071	0.706	2071	0.784	1973	98	4.96%	98	4.96%	98	4.96%	98	4.96%
STR1000	4	75	3474	14.06	3474	50.9691	3474	139.106	3474	46.39	3474	0	0%	0	0%	0	0%	0	0%
STR1000	4	100	4546	0	4546	1.1168	4546	0	4546	1.181	4546	0	0%	0	0%	0	0%	0	0%
STR1000	5	25	1217	12.018	1217	64.0328	1217	73.78	1217	52.8979	935	282	30.16%	282	30.16%	282	30.16%	282	30.16%
STR1000	5	50	2071	0.623	2071	0.7711	2071	0.759	2071	0.7855	1973	98	4.96%	98	4.96%	98	4.96%	98	4.96%
STR1000	5	75	3325	3.644	3325	9.4425	3325	3.644	3325	8.988	3325	0	0%	0	0%	0	0%	0	0%
STR1000	5	100	4403	0	4403	1.5678	4403	0	4403	1.5194	4403	0	0%	0	0%	0	0%	0	0%
STR1001	2	25	947	4.822	949.4	83.8014	950	70.963	950	50.783	947	0	0%	2.3999	0.25%	3	0.31%	3	0.31%
STR1001	2	50	2023	1.275	2023	16.3507	2023	1.275	2023	9.9895	2023	0	0%	0	0%	0	0%	0	0%
STR1001	2	75	3641	89.582	3655.6	178.0773	3669	185.917	3655.5	174.9225	3639	2	0.05%	16.5999	0.45%	30	0.82%	16.5	0.45%
STR1001	2	100	5000	13.394	5004.3	132.7714	5000	13.394	5004	133.368	5000	0	0%	4.3	0.08%	0	0%	4	0.08%
STR1002	2	25	1193	1.059	1193	3.8165	1193	1.059	1193	4.0115	1193	0	0%	0	0%	0	0%	0	0%
STR1002	2	50	3073	7.384	3073	66.5793	3073	7.384	3073	40.2935	3073	0	0%	0	0%	0	0%	0	0%
STR1002	2	75	4953	54.969	4957.6	134.5054	4953	97.998	4954.5	104.17	4953	0	0%	4.6	0.09%	0	0%	1.5	0.03%
STR1002	2	100	7090	56.266	7094.2	195.1736	7094	57.417	7094	232.3664	7089	1	0.01%	5.1999	0.07%	5	0.07%	5	0.07%
STR1003	2	25	1193	1.22	1193	4.5272	1193	1.22	1193	3.1365	1193	0	0%	0	0%	0	0%	0	0%
STR1003	2	50	3073	4.868	3073.1	49.2248	3073	10.278	3073	20.8744	3073	0	0%	0.0999	0%	0	0%	0	0%
STR1003	2	75	4953	3.161	4958	139.054	4953	3.161	4956	168.403	4953	0	0%	5	0.1%	0	0%	3	0.06%
STR1003	2	100	7089	33.784	7092.3	164.2802	7089	73.134	7092.5	148.088	7089	0	0%	3.3	0.04%	0	0%	3.5	0.04%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
STR1004	2	25	1860	0.723	1860	5.9194	1860	0.723	1860	2.029	1858	2	0.1%	2	0.1%	2	0.1%	2	0.1%
STR1004	2	50	3842	19.601	3842	67.9679	3842	19.601	3842	45.049	3842	0	0%	0	0%	0	0%	0	0%
STR1004	2	75	6406	55.025	6418.7	136.4365	6412	124.964	6417	131.358	6399	7	0.1%	19.6999	0.3%	13	0.2%	18	0.28%
STR1004	2	100	8699	45.81	8702.1	168.387	8699	117.977	8700.5	159.336	8699	0	0%	3.1	0.03%	0	0%	1.5	0.01%
STR1005	2	25	1860	0.783	1860	3.2033	1860	0.913	1860	1.8884	1858	2	0.1%	2	0.1%	2	0.1%	2	0.1%
STR1005	2	50	3842	6.261	3842	23.0864	3842	6.261	3842	23.0129	3842	0	0%	0	0%	0	0%	0	0%
STR1005	2	75	6405	15.19	6412.8	109.0445	6420	236.449	6411	108.987	6399	6	0.09%	13.8	0.21%	21	0.32%	12	0.18%
STR1005	2	100	8699	29.496	8701.2	151.7237	8699	128.091	8701	151.0595	8699	0	0%	2.2	0.02%	0	0%	2	0.02%
STR1006	2	25	1953	1.84	1953	5.1716	1953	1.84	1953	3.3475	1953	0	0%	0	0%	0	0%	0	0%
STR1006	2	50	4659	10.907	4661.5	123.5984	4659	10.907	4659	123.204	4659	0	0%	2.5	0.05%	0	0%	0	0%
STR1006	2	75	7455	54.552	7464.1	153.7984	7455	91.311	7464	144.756	7453	2	0.02%	11.1	0.14%	2	0.02%	11	0.14%
STR1006	2	100	10529	52.512	10533.6	169.7203	10531	154.144	10532.5	170.2945	10529	0	0%	4.6	0.04%	2	0.01%	3.5	0.03%
STR1007	2	25	1953	2.05	1953	6.1232	1953	2.05	1953	4.967	1953	0	0%	0	0%	0	0%	0	0%
STR1007	2	50	4659	72.731	4660.9	175.8265	4659	72.731	4659	200.1329	4659	0	0%	1.8999	0.04%	0	0%	0	0%
STR1007	2	75	7456	47.97	7464.2	157.4132	7456	222.224	7460	157.6795	7453	3	0.04%	11.1999	0.15%	3	0.04%	7	0.09%
STR1007	2	100	10529	34.684	10533.9	195.5448	10529	119.61	10533.5	205.7004	10529	0	0%	4.8999	0.04%	0	0%	4.5	0.04%
STR1008	2	25	2708	1.399	2712.8	60.4154	2713	1.911	2713	29.3235	2719	-11	-0.4%	-6.1999	-0.22%	-6	-0.22%	-6	-0.22%
STR1008	2	50	5629	13.086	5634.7	112.4539	5629	28.702	5636	43.4495	5629	0	0%	5.6999	0.1%	0	0%	7	0.12%
STR1008	2	75	9118	80.914	9131.2	186.4793	9118	229.294	9129.5	212.6415	9113	5	0.05%	18.2	0.19%	5	0.05%	16.5	0.18%
STR1008	2	100	12426	48.244	12428.3	136.703	12429	48.244	12428	102.2745	12426	0	0%	2.2999	0.01%	3	0.02%	2	0.01%
STR1009	2	25	2743	15.45	2744.4	120.5546	2743	45.112	2743	98.8735	2743	0	0%	1.4	0.05%	0	0%	0	0%
STR1009	2	50	5671	21.279	5676.9	73.8059	5671	21.279	5673	68.273	5671	0	0%	5.8999	0.1%	0	0%	2	0.03%
STR1009	2	75	9201	58.054	9218.2	179.8977	9206	71.068	9219.5	183.2085	9187	14	0.15%	31.2	0.33%	19	0.2%	32.5	0.35%
STR1009	2	100	12407	38.978	12410.7	128.7827	12407	167.432	12409	122.0255	12401	6	0.04%	9.7	0.07%	6	0.04%	8	0.06%
STR500	2	10	641	0.066	641	0.9722	641	0.066	641	0.7969	641	0	0%	0	0%	0	0%	0	0%
STR500	2	20	1572	1.235	1572	8.6666	1572	1.235	1572	7.399	1572	0	0%	0	0%	0	0%	0	0%
STR500	2	30	2407	0.127	2407	0.6705	2407	0.127	2407	0.792	2407	0	0%	0	0%	0	0%	0	0%
STR500	2	50	4420	1.108	4420	1.7027	4420	1.108	4420	1.731	4420	0	0%	0	0%	0	0%	0	0%
STR500	3	10	625	0.081	962.5	0.3378	1000	0.081	1000	0.3155	625	0	0%	337.5	54%	375	60%	375	60%
STR500	3	20	1551	2.197	1551	10.9083	1551	2.197	1551	8.9505	1551	0	0%	0	0%	0	0%	0	0%
STR500	3	30	2371	0.873	2371	2.5067	2371	0.873	2371	2.195	2371	0	0%	0	0%	0	0%	0	0%
STR500	3	50	4118	0.116	4118	0.2946	4118	0.116	4118	0.305	4118	0	0%	0	0%	0	0%	0	0%
STR500	4	10	625	0.07	887.5	0.2336	1000	0.075	1000	0.2415	625	0	0%	262.5	42%	375	60%	375	60%
STR500	4	20	1625	0.165	1625	0.2311	1625	0.211	1625	0.2205	1551	74	4.77%	74	4.77%	74	4.77%	74	4.77%
STR500	4	30	2275	0.232	2275	0.4475	2275	0.232	2275	0.392	2275	0	0%	0	0%	0	0%	0	0%
STR500	4	50	3956	0	3956	0.2415	3956	0	3956	0.2744	3956	0	0%	0	0%	0	0%	0	0%
STR500	5	10	625	0.068	737.5	0.1207	625	0.068	625	0.082	625	0	0%	112.5	18%	0	0%	0	0%
STR500	5	20	1625	0.172	1625	0.3061	1625	0.28	1625	0.327	1551	74	4.77%	74	4.77%	74	4.77%	74	4.77%
STR500	5	30	2275	0.456	2275	0.6304	2275	0.456	2275	0.6475	2275	0	0%	0	0%	0	0%	0	0%
STR500	5	50	3807	0	3807	0.3528	3807	0	3807	0.405	3807	0	0%	0	0%	0	0%	0	0%
STR502	2	10	832	4.574	833.1	66.3365	832	4.574	832	50.66	832	0	0%	1.1	0.13%	0	0%	0	0%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
STR502	2	20	2003	0.149	2003	0.2829	2003	0.149	2003	0.268	2003	0	0%	0	0%	0	0%	0	0%
STR502	2	30	3325	2.287	3325	9.1223	3325	2.287	3325	7.0165	3325	0	0%	0	0%	0	0%	0	0%
STR502	2	50	6126	2.127	6126	6.8353	6126	2.127	6126	6.09	6126	0	0%	0	0%	0	0%	0	0%
STR700	2	20	931	1.286	931	4.1318	931	1.286	931	3.7385	931	0	0%	0	0%	0	0%	0	0%
STR700	2	35	1881	0.727	1881.6	40.5179	1882	5.174	1882	2.437	1881	0	0%	0.5999	0.03%	1	0.05%	1	0.05%
STR700	2	50	3361	10.857	3366.1	118.5043	3366	16.822	3366	86.7435	3360	1	0.02%	6.0999	0.18%	6	0.17%	6	0.17%
STR700	2	70	4693	6.084	4693.7	32.5008	4693	6.084	4693	31.6605	4693	0	0%	0.6999	0.01%	0	0%	0	0%
STR700	3	20	1152	0.125	1152	0.1883	1152	0.191	1152	0.193	915	237	25.9%	237	25.9%	237	25.9%	237	25.9%
STR700	3	35	1843	0.375	1850.6	30.5567	1843	96.252	1843	19.414	1832	11	0.6%	18.5999	1.01%	11	0.6%	11	0.6%
STR700	3	50	3326	1.348	3328.4	54.4822	3330	3.716	3330	7.1615	3315	11	0.33%	13.4	0.4%	15	0.45%	15	0.45%
STR700	3	70	4397	0.469	4397	0.8733	4397	0.469	4397	0.819	4397	0	0%	0	0%	0	0%	0	0%
STR700	4	20	1150	0.151	1150	0.2041	1150	0.228	1150	0.2095	915	235	25.68%	235	25.68%	235	25.68%	235	25.68%
STR700	4	35	1878	0.282	1878	0.3647	1878	0.522	1878	0.3535	1832	46	2.51%	46	2.51%	46	2.51%	46	2.51%
STR700	4	50	3182	11.003	3182	32.7459	3182	11.003	3182	20.5185	3182	0	0%	0	0%	0	0%	0	0%
STR700	4	70	4245	0.155	4245	0.9947	4245	0.155	4245	1.0594	4245	0	0%	0	0%	0	0%	0	0%
STR700	5	20	1150	0.151	1150	0.1975	1150	0.234	1150	0.201	915	235	25.68%	235	25.68%	235	25.68%	235	25.68%
STR700	5	35	1878	0.338	1878	0.4647	1878	0.501	1878	0.488	1832	46	2.51%	46	2.51%	46	2.51%	46	2.51%
STR700	5	50	3038	0.148	3038	1.7141	3038	0.15	3038	1.3094	3038	0	0%	0	0%	0	0%	0	0%
STR700	5	70	4100	0	4100	0.4508	4100	0	4100	0.409	4100	0	0%	0	0%	0	0%	0	0%
SYM500	2	10	75	0.197	75	0.5112	75	0.197	75	0.5715	75	0	0%	0	0%	0	0%	0	0%
SYM500	2	20	272	1.482	272	7.8347	272	1.482	272	4.4985	272	0	0%	0	0%	0	0%	0	0%
SYM500	2	30	525	1.212	525	36.5299	525	1.212	525	14.204	525	0	0%	0	0%	0	0%	0	0%
SYM500	2	50	1765	22.117	1773.2	102.6614	1767	28.996	1769	74.4245	1759	6	0.34%	14.2	0.8%	8	0.45%	10	0.56%
SYM500	3	10	57	0.069	57	0.0807	57	0.074	57	0.0795	57	0	0%	0	0%	0	0%	0	0%
SYM500	3	20	199	0.117	199	0.1959	199	0.117	199	0.211	199	0	0%	0	0%	0	0%	0	0%
SYM500	3	30	394	0.345	394	0.8321	394	0.345	394	0.852	394	0	0%	0	0%	0	0%	0	0%
SYM500	3	50	1156	0.375	1156	0.696	1156	0.375	1156	0.693	1156	0	0%	0	0%	0	0%	0	0%
SYM500	4	10	57	0.055	57	0.0656	57	0.07	57	0.066	57	0	0%	0	0%	0	0%	0	0%
SYM500	4	20	199	0.172	199	0.382	199	0.172	199	0.4085	199	0	0%	0	0%	0	0%	0	0%
SYM500	4	30	373	0.255	373	0.4317	373	0.611	373	0.4235	373	0	0%	0	0%	0	0%	0	0%
SYM500	4	50	1105	0.371	1105	0.5192	1105	0.371	1105	0.508	1105	0	0%	0	0%	0	0%	0	0%
SYM500	5	10	57	0.079	57	0.0852	57	0.082	57	0.083	57	0	0%	0	0%	0	0%	0	0%
SYM500	5	20	199	0.305	199	0.393	199	0.305	199	0.4055	199	0	0%	0	0%	0	0%	0	0%
SYM500	5	30	373	0.213	373	0.3241	373	0.213	373	0.3445	373	0	0%	0	0%	0	0%	0	0%
SYM500	5	50	1098	0	1098	0	1098	0	1098	0	1098	0	0%	0	0%	0	0%	0	0%
SYM502	2	10	108	0.07	108	0.0845	108	0.083	108	0.0854	108	0	0%	0	0%	0	0%	0	0%
SYM502	2	20	372	2.692	372	85.2011	372	2.692	372	53.4335	372	0	0%	0	0%	0	0%	0	0%
SYM502	2	30	716	6.819	718.9	160.6002	716	291.006	716	177.279	696	20	2.87%	22.8999	3.29%	20	2.87%	20	2.87%
SYM502	2	50	2116	9.769	2144.2	76.1598	2150	12.659	2150	90.324	2116	0	0%	28.1999	1.33%	34	1.6%	34	1.6%
SYM503	2	10	107	0.069	107	0.0808	107	0.069	107	0.079	107	0	0%	0	0%	0	0%	0	0%
SYM503	2	20	282	0.099	282	0.2202	282	0.116	282	0.1545	282	0	0%	0	0%	0	0%	0	0%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
SYM503	2	30	586	1.548	586	21.7334	586	1.548	586	12.7244	586	0	0%	0	0%	0	0%	0	0%
SYM503	2	50	1965	3.098	1980.5	80.2807	1965	5.962	1965	66.734	1965	0	0%	15.5	0.78%	0	0%	0	0%
SYM508	2	10	70	0.071	70	0.0952	70	0.078	70	0.101	70	0	0%	0	0%	0	0%	0	0%
SYM508	2	20	296	0.849	296	2.4109	296	0.849	296	1.6145	296	0	0%	0	0%	0	0%	0	0%
SYM508	2	30	600	1.957	602.6	61.6643	600	49.14	602	69.162	600	0	0%	2.6	0.43%	0	0%	2	0.33%
SYM508	2	50	1861	5.825	1871	129.6297	1869	299.409	1869	125.5405	1861	0	0%	10	0.53%	8	0.42%	8	0.42%
SYM700	2	20	170	0.742	170	2.1103	170	0.742	170	1.6075	170	0	0%	0	0%	0	0%	0	0%
SYM700	2	35	407	10.719	409.9	97.5163	407	14.947	409	88.6794	407	0	0%	2.8999	0.71%	0	0%	2	0.49%
SYM700	2	50	831	24.347	843.8	161.2313	832	139.769	840	151.5575	818	13	1.58%	25.7999	3.15%	14	1.71%	22	2.68%
SYM700	2	70	2036	49.702	2099.5	141.3443	2036	119.974	2097	113.4915	2012	24	1.19%	87.5	4.34%	24	1.19%	85	4.22%
SYM701	2	20	165	1.414	165	6.3326	165	1.414	165	3.6755	165	0	0%	0	0%	0	0%	0	0%
SYM701	2	35	398	6.405	407.2	77.8797	398	12.847	403	14.9895	398	0	0%	9.1999	2.31%	0	0%	5	1.25%
SYM701	2	50	746	3.015	765.7	88.1434	760	48.649	763.5	60.4325	730	16	2.19%	35.7	4.89%	30	4.1%	33.5	4.58%
SYM701	2	70	1937	29.848	1997	138.1885	2035	116.089	1992	134.567	1931	6	0.31%	66	3.41%	104	5.38%	61	3.15%
SYM702	2	20	154	1.305	166.5	4.3668	172	3.648	172	3.849	154	0	0%	12.5	8.11%	18	11.68%	18	11.68%
SYM702	2	35	414	9.703	422.9	91.9856	421	31.72	421.5	37.6225	414	0	0%	8.8999	2.14%	7	1.69%	7.5	1.81%
SYM702	2	50	876	41.466	896.5	180.1981	887	252.447	890.5	186.175	845	31	3.66%	51.5	6.09%	42	4.97%	45.5	5.38%
SYM702	2	70	1916	71.146	1964.9	196.8421	1987	175.94	1973	214.6295	1864	52	2.78%	100.9	5.41%	123	6.59%	109	5.84%
SYM703	2	20	131	0.273	131	0.6295	131	0.274	131	0.614	131	0	0%	0	0%	0	0%	0	0%
SYM703	2	35	397	6.691	401.9	78.6508	397	36.051	399	34.0995	397	0	0%	4.8999	1.23%	0	0%	2	0.5%
SYM703	2	50	705	38.283	721.8	163.7481	717	271.441	720	154.329	688	17	2.47%	33.7999	4.91%	29	4.21%	32	4.65%
SYM703	2	70	1511	15.11	1555.3	181.6642	1567	195.197	1552	215.787	1497	14	0.93%	58.2999	3.89%	70	4.67%	55	3.67%
SYM704	2	20	190	1.886	190	11.6756	190	1.886	190	12.466	190	0	0%	0	0%	0	0%	0	0%
SYM704	2	35	432	5.623	441.9	128.1145	439	5.623	439	133.6635	430	2	0.46%	11.8999	2.76%	9	2.09%	9	2.09%
SYM704	2	50	791	20.059	816.8	140.7353	806	155.621	812.5	163.418	783	8	1.02%	33.7999	4.31%	23	2.93%	29.5	3.76%
SYM704	2	70	2050	82.596	2115.5	182.298	2125	145.419	2119.5	189.9515	2017	33	1.63%	98.5	4.88%	108	5.35%	102.5	5.08%
SYM705	2	20	241	1.654	241	3.3321	241	1.654	241	2.3754	241	0	0%	0	0%	0	0%	0	0%
SYM705	2	35	536	26.158	540.7	126.7256	536	43.536	539.5	126.2515	532	4	0.75%	8.7	1.63%	4	0.75%	7.5	1.4%
SYM705	2	50	952	19.265	982.2	66.4574	969	59.098	973.5	44.606	935	17	1.81%	47.2	5.04%	34	3.63%	38.5	4.11%
SYM705	2	70	2165	34.141	2215.1	183.3361	2220	115.103	2220	195.3525	2152	13	0.6%	63.0999	2.93%	68	3.15%	68	3.15%
SYM706	2	20	118	0.178	118	0.6818	118	0.178	118	0.667	118	0	0%	0	0%	0	0%	0	0%
SYM706	2	35	279	9.938	285.7	119.9558	286	54.769	286	155.709	279	0	0%	6.6999	2.4%	7	2.5%	7	2.5%
SYM706	2	50	566	6.829	588.2	168.3627	566	182.516	588	192.1689	566	0	0%	22.2	3.92%	0	0%	22	3.88%
SYM706	2	70	1512	44.539	1562.4	176.1024	1601	263.558	1561.5	174.894	1489	23	1.54%	73.4	4.92%	112	7.52%	72.5	4.86%
SYM707	2	20	203	0.962	203	11.5124	203	0.962	203	9.4795	203	0	0%	0	0%	0	0%	0	0%
SYM707	2	35	452	16.537	457.6	78.9582	452	16.537	452	52.5275	452	0	0%	5.6	1.23%	0	0%	0	0%
SYM707	2	50	906	19.439	928.3	121.2204	906	286.585	932	101.354	902	4	0.44%	26.2999	2.91%	4	0.44%	30	3.32%
SYM707	2	70	2385	44.077	2441.2	182.1382	2500	277.793	2432	208.0225	2371	14	0.59%	70.1999	2.96%	129	5.44%	61	2.57%
SYM708	2	20	241	22.669	243.8	89.4388	241	22.669	241	79.9455	241	0	0%	2.8	1.16%	0	0%	0	0%
SYM708	2	35	529	6.758	537.3	156.388	532	290.565	532	152.044	529	0	0%	8.2999	1.56%	3	0.56%	3	0.56%
SYM708	2	50	904	16.837	924.5	126.041	904	103.414	923	118.299	898	6	0.66%	26.5	2.95%	6	0.66%	25	2.78%

Instance	d	k	min_v	min_t	avg_v	avg_t	mod_v	mod_t	med_v	med_t	lp	min_d	min_g	avg_d	avg_g	mod_d	mod_g	med_d	med_g
SYM708	2	70	1832	74.638	1868.6	165.3127	1852	91.314	1869.5	168.361	1816	16	0.88%	52.5999	2.89%	36	1.98%	53.5	2.94%
SYM709	2	20	137	3.369	137	76.8171	137	3.369	137	69.2005	137	0	0%	0	0%	0	0%	0	0%
SYM709	2	35	359	5.05	359.5	66.1582	359	32.691	359	40.0155	357	2	0.56%	2.5	0.7%	2	0.56%	2	0.56%
SYM709	2	50	723	12.978	740.7	116.5507	744	137.28	742.5	93.973	696	27	3.87%	44.7	6.42%	48	6.89%	46.5	6.68%
SYM709	2	70	1755	52.094	1828.6	191.9254	1839	52.094	1837	200.4275	1749	6	0.34%	79.5999	4.55%	90	5.14%	88	5.03%
berlin52	2	10	279.2318	0.11	279.2318	0.1353	279.2318	0.126	279.2318	0.132	279.232	-0.0001	0%	-0.0001	0%	-0.0001	0%	-0.0001	0%
berlin52	2	20	1015.3907	0.139	1015.3907	0.201	1015.3907	0.144	1015.3907	0.204	1015.39	0.0007	0%	0.0007	0%	0.0007	0%	0.0007	0%
berlin52	2	30	2065.12	0.678	2065.12	1.1337	2065.12	0.678	2065.12	1.1175	2065.12	0	0%	0	0%	0	0%	0	0%
berlin52	2	52	6968.7674	4.147	6968.7674	14.6965	6968.7674	4.147	6968.7674	11.8735	6968.77	-0.0025	0%	-0.0025	0%	-0.0025	0%	-0.0025	0%
berlin52	3	10	274.4557	0	274.4557	0	274.4557	0	274.4557	0	274.456	-0.0002	0%	-0.0002	0%	-0.0002	0%	-0.0002	0%
berlin52	3	20	926.7662	0.081	926.7662	0.0942	926.7662	0.081	926.7662	0.0925	926.766	0.0002	0%	0.0002	0%	0.0002	0%	0.0002	0%
berlin52	3	30	1935.7117	0.077	1935.7117	0.1019	1935.7117	0.077	1935.7117	0.102	1935.71	0.0017	0%	0.0017	0%	0.0017	0%	0.0017	0%
berlin52	3	52	6081.6305	0	6081.6305	0	6081.6305	0	6081.6305	0	6081.63	0.0005	0%	0.0005	0%	0.0005	0%	0.0005	0%
ch150	2	50	1669.0804	24.939	1679.399	83.9812	1679.2497	61.769	1679.2497	63.525	1659.28	9.8004	0.59%	20.119	1.21%	19.9697	1.2%	19.9697	1.2%
ch150	2	80	2868.0748	87.062	2916.111	182.9332	2957.0531	98.954	2906.2505	169.163	2795.95	72.1248	2.57%	120.161	4.29%	161.1031	5.76%	110.3005	3.94%
ch150	2	100	3786.1207	117.243	3848.6373	206.5421	3852.0644	265.651	3835.3402	213.731	3627.93	158.1907	4.36%	220.7073	6.08%	224.1344	6.17%	207.4102	5.71%
ch150	2	150	6403.8397	99.784	6454.1969	201.8144	6403.8397	153.81	6455.5297	212.4645	6368.79	35.0497	0.55%	85.4069	1.34%	35.0497	0.55%	86.7397	1.36%
ch150	3	50	1567.7658	1.564	1567.7658	2.8212	1567.7658	1.564	1567.7658	3.098	1567.77	-0.0041	0%	-0.0041	0%	-0.0041	0%	-0.0041	0%
ch150	3	80	2642.0417	0.796	2642.5134	81.8591	2642.0417	6.371	2642.0417	21.5084	2642.04	0.0017	0%	0.4734	0.01%	0.0017	0%	0.0017	0%
ch150	3	100	3399.1653	3.012	3399.1773	41.2388	3399.1653	7.171	3399.1653	12.3924	3399.17	-0.0046	0%	0.0073	0%	-0.0046	0%	-0.0046	0%
ch150	3	150	5882.4499	0	5882.4499	1.0599	5882.4499	0	5882.4499	1.0145	5882.45	0	0%	0	0%	0	0%	0	0%
gr96	2	25	74.5942	1.024	74.5942	4.016	74.5942	6.754	74.5942	4.503	73.557	1.0372	1.41%	1.0372	1.41%	1.0372	1.41%	1.0372	1.41%
gr96	2	50	171.1384	46.469	171.7519	138.0905	171.3413	166.565	171.3413	138.1039	168.533	2.6054	1.54%	3.2189	1.9%	2.8083	1.66%	2.8083	1.66%
gr96	2	75	285.8613	19.098	286.2326	118.4947	285.9319	70.593	285.9319	106.0405	283.138	2.7233	0.96%	3.0946	1.09%	2.7939	0.98%	2.7939	0.98%
gr96	2	96	474.945	68.062	476.0656	127.3029	476.0847	108.32	476.0847	115.6245	474.945	0	0%	1.1206	0.23%	1.1397	0.23%	1.1397	0.23%
gr96	3	25	72.4005	1.638	72.4005	27.787	72.4005	1.638	72.4005	22.4545	72.4005	0	0%	0	0%	0	0%	0	0%
gr96	3	50	162.7993	1.742	163.1197	81.6508	162.7993	28.929	162.7993	64.308	162.799	0.0003	0%	0.3207	0.19%	0.0003	0%	0.0003	0%
gr96	3	75	267.5672	2.906	267.5672	51.3787	267.5672	2.906	267.5672	45.9595	267.567	0.0002	0%	0.0002	0%	0.0002	0%	0.0002	0%
gr96	3	96	436.2273	0	436.2273	0	436.2273	0	436.2273	0	436.227	0.0003	0%	0.0003	0%	0.0003	0%	0.0003	0%
pa561	2	140	470	108.738	483.6	211.1337	477	199.993	477	219.385	-	-	-	-	-	-	-	-	-
pa561	2	280	1152	2.701	1177.1	182.2799	1165	6.189	1165.5	249.902	-	-	-	-	-	-	-	-	-
pa561	2	420	1952	2.19	1990	5.9475	1973	5.45	1974	4.9225	-	-	-	-	-	-	-	-	-
pa561	2	561	2875	2.734	2903	39.1354	2924	52.891	2906.5	16.716	-	-	-	-	-	-	-	-	-
pa561	3	140	393	2.963	396.2	79.0779	396	3.56	396	44.447	-	-	-	-	-	-	-	-	-
pa561	3	280	888	5.982	892.4	23.0624	890	48.232	891.5	12.7275	-	-	-	-	-	-	-	-	-
pa561	3	420	1528	21.328	1535.4	119.4788	1535	293.173	1535	85.554	-	-	-	-	-	-	-	-	-
pa561	3	561	2402	124.376	2404.4	210.5939	2405	272.56	2404.5	214.1985	-	-	-	-	-	-	-	-	-
# Times opt.			305		226		270		246		414								
% Times opt.			71.26		52.80		63.08		57.48		96.72								

Table 5: Comparison of the VNS-LIMA and LP results

B Appendix: LP results without proof of optimality

Instance	d	k	$Sol.$	LB	Gap
STR1000	2	75	3639	3430	6.09%
STR1000	3	75	3579	3357	6.61%
STR1000	4	75	3474	3300	5.27%
STR1001	2	75	3639	3434	5.97%
STR1004	2	25	1858	1602	15.97%
STR1004	2	75	6399	6158	3.91%
STR1005	2	25	1858	1602	15.97%
STR1005	2	75	6399	6158	3.91%
STR1008	2	25	2719	2456	10.70%
STR1008	2	75	9113	8917	2.20%
STR1009	2	25	2743	2449	12.00%
STR1009	2	75	9187	8970	2.42%
STR700	2	50	3360	3076	9.23%
STR700	3	50	3315	3018	9.84%

Table 6: LP Solver results without proof of optimality. Column Sol. represents the best solution found after 3600s, and column LB represents the lower bound.