Dual Conflict Analysis for Mixed-Integer Semidefinite Programs

Marc E. Pfetsch
Department of Mathematics,
TU Darmstadt, Germany

July 2023

Abstract

Conflict analysis originally tried to exploit the knowledge that certain nodes in a relaxation-based branch-and-bound are infeasible. It has been extended to derive valid constraints also from feasible nodes. This paper adapts this approach to mixed-integer semidefinite programs. Using dual solutions, the primal constraints are aggregated and the resulting inequalities can be used at different nodes in the tree to tighten variable bounds. We show that this helps to speed up the solutions times by about 8 % on our testset.

1 Introduction

We consider the solution of *mixed-integer semidefinite programs* (MISDPs) of the following general form:

$$\inf \left\{ b^\top y \,:\, \sum_{k=1}^{m} A^k\, y_k - A^0 \succeq 0,\ Dy \geq d,\ \ell \leq y \leq u,\ y_i \in \mathbb{Z}\ \forall\, i \in I \right\}, \quad (1)$$

where $M \succeq 0$ means that some matrix M is positive semidefinite. Moreover, $A^k \in \mathbb{R}^{n\times n}$ is symmetric for all $k \in \{0,\dots,m\}$, $b \in \mathbb{R}^m$, $D \in \mathbb{R}^{r\times m}$, $d \in \mathbb{R}^r$, $\ell_i \in \mathbb{R} \cup \{-\infty\}$, $u_i \in \mathbb{R} \cup \{\infty\}$ for all $i \in [m] \coloneqq \{1,\dots,m\}$; we assume $\ell \leq u$ throughout the article. Integer variables are indexed by $I \subseteq [m]$.

One common approach to solve (1) is SDP-based branch-and-bound, where one branches on the integer variables and solves semidefinite programs (SDPs) in each node. This is a special case of nonlinear programming based branch-and-bound, see Dakin [5]. We will use this approach in the following.

Conflict analysis (or *infeasibility analysis*) originally had the idea to use information of infeasible nodes in a branch-and-bound tree to generate constraints which exclude certain infeasible variable assignments. First considered for SAT-solving, it was transferred to the solution of mixed-integer programs (MIPs) by Achterberg [1]. There are currently three types of conflict analysis:

a) *Graph-based conflict analysis*: A directed graph encodes whether a bound of one variable was used to strengthen the bound of another variable. The goal is to find a small subset of bound changes that lead to infeasibility. See [1, 2] for more information in the context of MIPs. The application of this kind of conflict analysis for MISDPs turned out not to be beneficial [6], because there is a negligible number of infeasibilities that are detected by bound propagation (infeasibility detected by the relaxation is not used in this conflict analysis type).

b) *Greedy approach*: Starting from an infeasible relaxation, one greedily relaxes some branching decisions defining the current node as long as the relaxation remains infeasible. See [1, 2] for more information in the context of MIPs. This method does not seem very promising for MISDPs, since warm starting is difficult in this setting and resolving is thus much more expensive.

c) *Dual proof analysis:* Dual information of infeasible and feasible nodes can be used to derive valid constraints, which can then be propagated during the tree. This approach has been discussed by Witzig et al. [10, 8]; see also Witzig [7].

In the following, we will generalize the last approach to MISDPs and call it *dual conflict analysis*. Our approach can partly be seen as a special case of the approach for convex mixed-integer nonlinear programs by Witzig and Berthold [9]. Similar ideas are needed for an outer approximation algorithm, in which one adds aggregated inequalities that will cut off nodes that are infeasible or bound exceeding. Coey et al. [4] describe such an algorithm for mixed-integer conic problems (which includes MISDP).

The contribution of this paper is to make the approach explicit for MISDPs and present computational experiments of an implementation.

2 Preliminaries

We first consider the dual version of the SDP-relaxation of (1): let $X \in \mathbb{R}^{n \times n}$ be variables corresponding to the SDP-constraint $A(y) \coloneqq \sum_{k=1}^{m} A^k\, y_k - A^0 \succeq 0$, $z \in \mathbb{R}^r_+$ correspond to $Dy \geq d$, and r^ℓ, $r^u \in \mathbb{R}^m_+$ correspond to the bound constraints $y \geq \ell$ and $-y \geq -u$, respectively. Then the dual problem is:

$$\begin{aligned} \sup \quad & \langle A^0, X\rangle + d^\top z + \ell^\top r^\ell - u^\top r^u \\ \text{s.t.} \quad & \langle A^k, X\rangle + (D^\top z)_k + r^\ell_k - r^u_k = b_k \quad \forall\, k \in [m], \\ & X \succeq 0,\ z,\ r^\ell,\ r^u \geq 0. \end{aligned} \tag{2}$$

We will need the following easy result.

Lemma 1. Let $\hat{r}^\ell$, $\hat{r}^u \in \mathbb{R}^m_+$ with $\hat{r}^\ell - \hat{r}^u = \hat{s}$ for some $\hat{s} \in \mathbb{R}^m$. Then there exist r^ℓ, $r^u \in \mathbb{R}^m_+$ with $r^\ell - r^u = \hat{s}$, such that $r^\ell_k \cdot r^u_k = 0$ for all $k \in [m]$ and $\ell^\top r^\ell - u^\top r^u \geq \ell^\top \hat{r}^\ell - u^\top \hat{r}^u$.

Proof. Define $r^\ell_k \coloneqq \max\{\hat{s}_k, 0\} \geq 0$, $r^u_k = -\min\{\hat{s}_k, 0\} \geq 0$. By construction $r^\ell_k \cdot r^u_k = 0$ for all $k \in [m]$ and $r^\ell - r^u = \hat{s}$. Moreover,

$$\begin{aligned}
\ell_k r^\ell_k - u_k r^u_k &= \ell_k \, \max\{\hat{s}_k, 0\} + u_k \, \min\{\hat{s}_k, 0\} \\
&= \ell_k \, \max\{\hat{r}^\ell_k - \hat{r}^u_k, 0\} + u_k \, \min\{\hat{r}^\ell_k - \hat{r}^u_k, 0\} \\
&= \begin{cases} \ell_k \, (\hat{r}^\ell_k - \hat{r}^u_k) & \text{if } \hat{r}^\ell_k - \hat{r}^u_k \geq 0, \\ u_k \, (\hat{r}^\ell_k - \hat{r}^u_k) & \text{if } \hat{r}^\ell_k - \hat{r}^u_k < 0, \end{cases} \\
&\geq \ell_k \hat{r}^\ell_k - u_k \hat{r}^u_k,
\end{aligned}$$

which shows the claim. □

3 Conflict Analysis for MISDPs

The general idea of dual conflict analysis is to generate globally valid constraints as follows. Let any $\hat{X} \succeq 0$ and $\hat{z} \geq 0$ be given. Then because $A(y) \succeq 0$ for all feasible $y \in \mathbb{R}^m$, we have $\langle \hat{X}, A(y) \rangle \geq 0$. Similarly, the aggregated inequalities $\hat{z}^\top D y \geq \hat{z}^\top d$ hold. Together this yields the linear inequality:

$$\langle \hat{X}, A(y) \rangle + \hat{z}^\top D y \geq \hat{z}^\top d \quad \Leftrightarrow \quad \sum_{k=1}^{m} \big(\langle \hat{X}, A^k \rangle + (\hat{z}^\top D)_k \big) \, y_k \geq \langle \hat{X}, A^0 \rangle + \hat{z}^\top d. \tag{3}$$

Inequality (3) is redundant for all y with $A(y) \succeq 0$, $Dy \geq d$, but it might allow to cut off certain mixed-integer solutions y using local bounds. In the implementation, we only propagate local bounds using (3), but do not add the inequality to the SDP problem itself.

More generally, we can also use the variable bounds $\ell \leq y$ and $y \leq u$. If $\hat{r}^\ell$, $\hat{r}^u \geq 0$ are the corresponding multipliers, this yields the linear constraint:

$$\langle \hat{X}, A(y) \rangle + \hat{z}^\top D y + (\hat{r}^\ell)^\top y - (\hat{r}^u)^\top y \geq \hat{z}^\top d + (\hat{r}^\ell)^\top \ell - (\hat{r}^u)^\top u, \tag{4}$$

which is valid for all y with $A(y) \succeq 0$, $Dy \geq d$, $\ell \leq y \leq u$. Preliminary computations indicated that Inequalities (4) are less helpful than (3) – therefore we will use (3).

3.1 Infeasible Problems

Assume that a node in the tree is infeasible with respect to the local bounds ℓ and u. One way of proving infeasibility is through a *dual ray*, i.e., a point

$(\hat{X}, \hat{z}, \hat{r}^\ell, \hat{r}^u)$ satisfying the system

$$\begin{aligned}
&\langle A^k, X\rangle + (D^\top z)_k + r_k^\ell - r_k^u = 0 \qquad \forall\, k \in [m],\\
&\langle A^0, X\rangle + d^\top z + \ell^\top r^\ell - u^\top r^u > 0,\\
&X \succeq 0,\ z,\ r^\ell,\ r^u \geq 0.
\end{aligned} \tag{5}$$

One can then use such a point to produce an inequality as in (3) or (4). In this case, one can prove that (3) actually certifies infeasibility for the local bounds ℓ and u via propagation:

Proposition 1. Let $(\hat{X}, \hat{z}, \hat{r}^\ell, \hat{r}^u)$ be a dual ray which is used to create Inequality (3). Then (3) is infeasible with respect to the local bounds ℓ and u.

Proof. Assume there would exist a feasible solution $\hat{y}$ with respect to the local bounds, i.e., $A(\hat{y}) \succeq 0$, $D\hat{y} \geq d$, and $\ell \leq \hat{y} \leq u$. Defining $\hat{s}_k \coloneqq \langle \hat{X}, A^k\rangle + (\hat{z}^\top D)_k$ for $k \in [m]$, we get from (3):

$$\langle \hat{X}, A^0\rangle + \hat{z}^\top d \leq \sum_{k=1}^m \hat{s}_k\, \hat{y}_k \leq \sum_{k:\hat{s}_k<0} \hat{s}_k\, \ell_k + \sum_{k:\hat{s}_k>0} \hat{s}_k\, u_k. \tag{6}$$

Applying Lemma 1 to $\hat{r}^\ell - \hat{r}^u = -\hat{s}$, we can assume that $\hat{r}_k^\ell \cdot \hat{r}_k^u = 0$ for all $k \in [m]$ and the strict inequality in (5) is still satisfied. Thus,

$$0 < \langle A^0, \hat{X}\rangle + d^\top \hat{z} + \ell^\top \hat{r}^\ell - u^\top \hat{r}^u = \langle A^0, \hat{X}\rangle + d^\top \hat{z} - \sum_{k:\hat{s}_k<0} \ell_k\, \hat{s}_k - \sum_{k:\hat{s}_k>0} u_k\, \hat{s}_k,$$

a contradiction to (6). □

The hope is that (3) is still violated for local bounds not far from ℓ and u.

3.2 Feasible Problems

Any feasible solution $(\hat{X}, \hat{z}, \hat{r}^\ell, \hat{r}^u)$ of (2) can be used to construct (3) or (4).

Moreover, one can take an objective cutoff into account. Namely, assume that $\overline{y}$ is a feasible solution to (1). We are then only interested in solutions y that are better, i.e., $b^\top y \leq \overline{b}$ ($\Leftrightarrow -b^\top y \geq -\overline{b}$), where $\overline{b} \coloneqq b^\top \overline{y} - \varepsilon$ for $\varepsilon > 0$ ($\varepsilon = 1$ if $b^\top y$ is always integral). Adding this objective cut to (3) yields:

$$\sum_{k=1}^m \big(\langle \hat{X}, A^k\rangle + (\hat{z}^\top D)_k - b_k\big) y_k \geq \langle \hat{X}, A^0\rangle + \hat{z}^\top d - \overline{b}. \tag{7}$$

Proposition 2. Let $(\hat{X}, \hat{z}, \hat{r}^\ell, \hat{r}^u)$ be a solution of (2) for a local node with objective $\langle A^0, \hat{X}\rangle + d^\top \hat{z} + \ell^\top \hat{r}^\ell - u^\top \hat{r}^u > \overline{b}$, i.e., the node would be cut off by value. Then (7) is infeasible with respect to the local bounds ℓ and u.

Proof. Define $\hat{s}_k \coloneqq \langle \hat{X}, A^k \rangle + (\hat{z}^\top D)_k - b_k$ for $k \in [m]$. Then we get from (7) for any solution y with $b^\top y \leq \bar{b}$, $A(y) \succeq 0$, $Dy \geq d$, and $\ell \leq y \leq u$:

$$\langle \hat{X}, A^0 \rangle + \hat{z}^\top d - \bar{b} \leq \sum_{k=1}^{m} \hat{s}_k\, y_k \leq \sum_{k:\hat{s}_k<0} \hat{s}_k\, \ell_k + \sum_{k:\hat{s}_k>0} \hat{s}_k\, u_k. \tag{8}$$

The solution $(\hat{X}, \hat{z}, \hat{r}^\ell, \hat{r}^u)$ of (2) satisfies $\hat{r}^\ell - \hat{r}^u = -\hat{s}$. By Lemma 1, we can assume that $\hat{r}^\ell_k \cdot \hat{r}^u_k = 0$ for all $k \in [m]$. Thus,

$$\langle A^0, \hat{X} \rangle + d^\top \hat{z} + \ell^\top \hat{r}^\ell - u^\top \hat{r}^u = \langle A^0, \hat{X} \rangle + d^\top \hat{z} - \sum_{k:\hat{s}_k<0} \ell_k\, \hat{s}_k - \sum_{k:\hat{s}_k>0} u_k\, \hat{s}_k.$$

The assumption implies that

$$\sum_{k:\hat{s}_k<0} \ell_k\, \hat{s}_k + \sum_{k:\hat{s}_k>0} u_k\, \hat{s}_k < \langle A^0, \hat{X} \rangle + d^\top \hat{z} - \bar{b},$$

a contradiction to (8). □

Again, the hope in practice is that (7) is still violated for local bounds not far from $\ell \leq u$.

3.3 Canceling

Starting from (3), one can sometimes cancel coefficients as follows. Again using $\hat{s}_k \coloneqq \langle \hat{X}, A^k \rangle + (\hat{z}^\top D)_k$, we get from (3):

$$\sum_{k=1}^{m} \hat{s}_k\, y_k \geq \langle \hat{X}, A^0 \rangle + \hat{z}^\top d. \tag{9}$$

Assume that $\hat{s}_k < 0$ for some $k \in [m]$ and ℓ_k is a global lower bound of y_k. Then we can add the valid inequality $-\hat{s}_k\, y_k \geq -\hat{s}_k \ell_k$ to (9). This eliminates variable y_k from the inequality. Similarly, assume that $\hat{s}_k > 0$ for some $k \in [m]$ and u_k is a global upper bound of y_k. We can then add $-\hat{s}_k\, y_k \geq -\hat{s}_k u_k$ to (9).

In our implementation, we follow Witzig et al. [10] (see also Witzig [7]) who apply cancellation to continuous variables, but restrict attention to variables that are at their global bounds at the node at which the constraint is generated.

3.4 Computational Results

The above methods have been implemented using SCIP-SDP 4.2.0. SCIP-SDP is a MISDP-framework based on SCIP [3], licensed under Apache 2.0, and available at https://wwwopt.mathematik.tu-darmstadt.de/scipsdp/. We compiled SCIP-SDP with a developer version of SCIP 8.0.4 (githash

Table 1: Results of different dual conflict analysis methods; *left:* all 185 instances; *right:* 166 instances solved to optimality by all variants.

variant	#solved	#nodes	time	#conf
default	167	1080.2	134.4	—
infeas	168	1050.7	130.6	6.24
feas	168	1031.9	127.5	749.67
feas-obj	167	994.9	130.9	675.16
both	168	1002.5	124.2	818.53
both-cancel	168	1006.6	127.2	827.28
both-cmir	168	1017.8	127.5	832.69

variant	#nodes	time
default	799.4	95.8
infeas	775.2	92.9
feas	761.4	90.4
feas-obj	740.2	93.0
both	735.9	87.8
both-cancel	740.1	90.2
both-cmir	748.3	90.4

`1870b6a`) and used Mosek 9.2.40 for solving SDP-relaxations. All tests were performed on a Linux cluster with 3.5 GHz Intel Xeon E5-1620 Quad-Core CPUs, having 32 GB main memory and 10 MB cache. The computations were run single-threaded and with a time limit of one hour. We use the same 185 instances as in [6], which arise from a variety of applications.

Aggregated results are shown in Table 3.4, which gives the number of solved instances, the shifted geometric mean of the number of nodes, time (in seconds), and number of generated conflict constraints; the shifted geometric mean of values $t_1, \dots, t_n$ is defined as $(\prod_{i=1}^{n}(t_i + s))^{1/n} - s$, where $s =$ 100, 1, and 1, respectively. Variant "infeas" generates cuts as described in Section 3.1, but produces the fewest number of conflict constraints because there are few infeasible nodes. Variant "feas" only generates conflict constraints for feasible nodes and "feas-obj" in addition uses objective cuts (see Section 3.2). Both generate a significant number of conflict constraints. However, using objective cuts reduces the number of nodes, but not the running time. One reason is that, contrary to [8], we do not update the bounds $\overline{b}$ after the generation of conflict constraints.

Variant "both" combines both approaches (without objective cut) and produces the best results with a speed-up of about 8 %. Additionally applying canceling ("both-cancel", see Section 3.3) or complemented mixed integer rounding (CMIR, "both-cmir") slightly worsen the results.

4 Conclusion

Overall, dual conflict analysis is a general method that improves performance by about 8 %, which is in roughly the same speed-up range as for mixed-integer programs. An interesting open question is whether one can "sparsify" the dual information to generate stronger conflict constraints.

References

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A Detailed Computational Results

Table 2: Detailed statistics for each instance and **default settings**.

name	# nodes	time	# conss
coloncancer_101_200_7	4955	483.39	0
coloncancer_201_300_9	2023	268.71	0
coloncancer_301_400_11	5171	665.79	0
coloncancer_401_500_13	177	27.48	0
coloncancer_501_600_15	137	24.93	0
coloncancer_601_700_17	1691	239.72	0
coloncancer_701_800_19	1103	140.05	0
coloncancer_801_900_21	8027	860.23	0
coloncancer_901_1000_23	15 309	2174.50	0
coloncancer_1001_1100_6	359	51.35	0
coloncancer_1101_1200_8	1829	249.88	0
coloncancer_1201_1300_10	4735	603.17	0
coloncancer_1301_1400_12	7385	1148.79	0
coloncancer_1401_1500_14	1479	204.40	0
coloncancer_1501_1600_16	917	135.97	0
coloncancer_1601_1700_18	23 395	3600.00	0
coloncancer_1701_1800_20	31 179	3600.01	0
coloncancer_1801_1900_22	4463	537.26	0
coloncancer_1901_2000_24	1185	205.93	0
random_64_6_a	1	13.95	0
random_64_6_b	1	13.79	0
random_64_6_c	1	13.64	0
random_64_8_a	1	30.23	0
random_64_8_b	1	31.67	0
random_64_8_c	1	31.67	0
random_96_4_a	1	23.42	0
random_96_4_b	1	18.75	0
random_96_4_c	1	18.40	0
random_96_6_a	1	52.59	0
random_96_6_b	1	55.28	0
random_96_6_c	1	52.92	0
random_96_8_a	1	114.74	0
random_96_8_b	1	109.10	0
random_96_8_c	1	108.76	0
random_128_2_a	9	36.74	0
random_128_2_b	11	27.81	0
random_128_2_c	15	45.31	0
random_128_4_a	1	54.06	0
random_128_4_b	1	56.36	0
random_128_4_c	1	68.92	0
random_128_6_a	1	152.15	0
random_128_6_b	1	156.96	0

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name	# nodes	time	# conss
random_128_6_c	1	158.48	0
diw_34	13	1.81	0
diw_37	23	5.20	0
diw_38	104	28.86	0
diw_43	15	6.15	0
diw_44	15	6.94	0
diw_46	1241	805.34	0
diw_48	1360	1063.07	0
2g_6_701_k4_9_9	39	8.79	0
2g_7_77_k3_16_17	1948	1961.24	0
2pm_5_55_k6_4_5	169	4.56	0
3g_244_244_k2_16_16	79	16.32	0
clique_60_k20_3_3	11	6.77	0
clique_60_k6_10_10	19	23.36	0
2g_6_701_k5_7_8	376	68.32	0
3g_244_244_k3_10_11	98	19.22	0
3pm_234_234_k5_5_6	400	12.94	0
clique_60_k7_8_9	178	284.07	0
2g_6_701_k10_3_4	83	15.22	0
3g_244_244_k4_8_8	159	20.82	0
clique_60_k8_7_8	328	497.60	0
2g_6_701_k7_5_6	72	15.13	0
clique_60_k9_6_7	425	496.31	0
2g_6_701_k2_18_18	139	49.23	0
2g_6_701_k8_4_5	134	26.65	0
3g_244_244_k6_5_6	172	20.89	0
clique_60_k10_6_6	51	76.14	0
clique_60_k4_15_15	9	13.88	0
clique_70_k3_23_24	19	118.40	0
2g_6_701_k3_12_12	285	75.00	0
2g_6_701_k9_4_4	909	119.04	0
clique_60_k15_4_4	34	50.39	0
clique_60_k5_12_12	19	29.20	0
4x5_2bars	16 003	381.10	0
bridge_2x9_2bars	18 395	252.07	0
bridge_3x9_2bars	105 031	3600.00	0
2x5_1scen_6bars	10 926	79.58	0
3x4_1scen_4bars	13 095	85.64	0
5x5_1bar	107 494	3600.01	0
bridge_2x9_2bars_nominal	7118	90.27	0
demonst_1bar_3scen	254 476	3600.00	0
2x4_2scen_3bars	6426	27.18	0
3x3_2scen_6bars	3272	19.34	0
3x4_1scen_6bars	4678	107.08	0
bridge_2x10_2bars_2scen	197 660	3600.00	0
demonst_2bars_2scen	94 651	1147.40	0
test_bridge2	5187	26.86	0
2x5_2scen_3bars	6977	56.82	0
3x3_2scen_8bars	2832	24.78	0
3x4_1scen_8bars	752	22.57	0
demonstsmall_1bar_4scen	13 017	40.01	0
test_bridge3	2385	19.05	0
2x5_2scen_4bars	7525	58.06	0
bridge_2x6_4bars_2scen	37 553	223.14	0
bridge_3x6_2bars_2scen	25 317	271.70	0
2x5_3bars	5533	45.08	0
3x3_3scen_6bars	10 986	73.59	0

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name	# nodes	time	# conss
4x3_2bars_3scen	7483	53.88	0
2x4_8bars_2scen	11 912	52.35	0
2x6_3bars	10 336	110.31	0
3x3_3scen_8bars	11 092	67.33	0
4x4_1bar_2scen	337 478	3600.01	0
bridge_2x8_2bars_2scen	38 745	327.80	0
bridge_3x7_2bars_nominal	9370	143.18	0
2x5_1scen_12bars	7336	98.48	0
2x7_3bars	91 899	1852.84	0
3x3_3scen	20 229	128.71	0
4x4_1bar	10 176	79.19	0
bridge_2x8_2bars_2scen_nominal	13 346	231.41	0
bridge_3x8_1bar_2scen	2827	49.76	0
demonstsmall_2bars_2scen	4442	19.34	0
0+-115305C_MISDPld000010	146	4.20	0
0+-115305C_MISDPrd000010	1459	46.38	0
0+-125354B_MISDPld000010	5629	143.88	0
0+-125354B_MISDPrd000010	4665	127.85	0
0+-130403E_MISDPld000010	2775	93.39	0
0+-130403E_MISDPrd000010	771	51.77	0
0+-140605A_MISDPld000010	6642	3600.01	0
0+-140605A_MISDPrd000010	3430	3600.03	0
band40403B_MISDPld000010	103	20.98	0
band40403B_MISDPrd000010	83	15.19	0
band60605D_MISDPld000010	16	35.87	0
band60605D_MISDPrd000010	11	31.80	0
band70704A_MISDPld000010	4128	2739.42	0
band70704A_MISDPrd000010	55	228.68	0
bern15305D_MISDPld000010	17 243	219.78	0
bern15305D_MISDPrd000010	1053	37.98	0
bern25354A_MISDPld000010	8437	177.77	0
bern25354A_MISDPrd000010	5347	137.10	0
bern30403C_MISDPld000010	3097	98.21	0
bern30403C_MISDPrd000010	3503	100.56	0
bern40605A_MISDPld000010	6332	3600.02	0
bern40605A_MISDPrd000010	3456	3600.02	0
bina15305D_MISDPld000010	20 143	264.02	0
bina15305D_MISDPrd000010	78 154	633.12	0
bina25354E_MISDPld000010	12 891	243.45	0
bina25354E_MISDPrd000010	47 619	410.69	0
bina30403B_MISDPld000010	5669	134.59	0
bina30403B_MISDPrd000010	13 699	149.02	0
bina40605B_MISDPld000010	5453	3600.04	0
bina40605B_MISDPrd000010	3570	3600.02	0
norm15305B_MISDPld000010	18 896	252.76	0
norm15305B_MISDPrd000010	1147	45.61	0
norm25354A_MISDPld000010	7061	179.74	0
norm25354A_MISDPrd000010	907	57.28	0
norm30403D_MISDPld000010	3179	108.91	0
norm30403D_MISDPrd000010	1761	84.65	0
norm40605D_MISDPld000010	5544	3600.03	0
norm40605D_MISDPrd000010	2989	3600.01	0
wish15305A_MISDPld000010	18 781	235.46	0
wish15305A_MISDPrd000010	1625	52.12	0
wish25354C_MISDPld000010	6179	149.56	0
wish25354C_MISDPrd000010	2257	86.84	0
wish30403D_MISDPld000010	2777	93.24	0

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name	# nodes	time	# conss
wish30403D_MISDPrd000010	459	39.07	0
wish40605E_MISDPld000010	6589	3600.06	0
wish40605E_MISDPrd000010	3459	3600.02	0
randomMISDP_120_120_120_0.1	78	337.09	0
randomMISDP_120_120_120_10	105	649.02	0
randomMISDP_120_90_90_0.1	62	302.17	0
randomMISDP_120_90_90_10	82	257.56	0
randomMISDP_60_90_90_10	153	104.96	0
randomMISDP_90_120_90_0.1	88	164.33	0
randomMISDP_90_120_90_10	153	312.67	0
randomMISDP_90_60_90_10	42	56.61	0
randomMISDP_90_90_120_0.1	74	128.25	0
randomMISDP_90_90_120_10	91	193.58	0
randomMISDP_90_90_60_10	74	83.67	0
randomMISDP_90_90_90_0.1	62	98.50	0
randomMISDP_90_90_90_10	83	134.13	0
randomMISDP_PSD_120_120_120_0.1	142	2222.25	0
randomMISDP_PSD_120_120_120_10	145	1589.94	0
randomMISDP_PSD_120_90_90_0.1	106	450.52	0
randomMISDP_PSD_120_90_90_10	119	964.67	0
randomMISDP_PSD_60_90_90_10	107	87.58	0
randomMISDP_PSD_90_120_90_0.1	140	438.88	0
randomMISDP_PSD_90_120_90_10	143	480.36	0
randomMISDP_PSD_90_60_90_10	73	160.59	0
randomMISDP_PSD_90_90_120_0.1	104	267.75	0
randomMISDP_PSD_90_90_120_10	107	331.91	0
randomMISDP_PSD_90_90_60_10	127	344.75	0
randomMISDP_PSD_90_90_90_0.1	104	313.98	0
randomMISDP_PSD_90_90_90_10	109	289.81	0

Table 3: Detailed statistics for each instance and **"infeas" settings**.

name	# nodes	time	# conss
coloncancer_101_200_7	4929	477.53	4298
coloncancer_201_300_9	2003	261.80	1975
coloncancer_301_400_11	2603	389.69	1513
coloncancer_401_500_13	125	22.68	121
coloncancer_501_600_15	117	21.64	114
coloncancer_601_700_17	1398	178.66	847
coloncancer_701_800_19	837	108.21	523
coloncancer_801_900_21	4757	508.36	2614
coloncancer_901_1000_23	12 955	1596.04	14 233
coloncancer_1001_1100_6	337	45.50	279
coloncancer_1101_1200_8	1685	208.21	914
coloncancer_1201_1300_10	4005	502.55	4135
coloncancer_1301_1400_12	5401	782.24	4766
coloncancer_1401_1500_14	1111	148.44	758
coloncancer_1501_1600_16	689	100.91	475
coloncancer_1601_1700_18	24 742	3600.00	28 560
coloncancer_1701_1800_20	29 224	3064.04	20 155
coloncancer_1801_1900_22	3521	422.16	3262
coloncancer_1901_2000_24	419	84.70	290
random_64_6_a	1	13.94	0
random_64_6_b	1	13.76	0
random_64_6_c	1	13.65	0
random_64_8_a	1	30.19	0
random_64_8_b	1	31.73	0
random_64_8_c	1	31.67	0
random_96_4_a	1	23.30	0
random_96_4_b	1	18.69	0
random_96_4_c	1	18.31	0
random_96_6_a	1	52.83	0
random_96_6_b	1	55.37	0
random_96_6_c	1	52.87	0
random_96_8_a	1	114.58	0
random_96_8_b	1	110.24	0
random_96_8_c	1	109.21	0
random_128_2_a	9	36.62	7
random_128_2_b	11	27.73	9
random_128_2_c	15	45.95	11
random_128_4_a	1	53.82	0
random_128_4_b	1	56.35	0
random_128_4_c	1	68.86	0
random_128_6_a	1	151.39	0
random_128_6_b	1	151.80	0
random_128_6_c	1	158.29	0
diw_34	13	1.79	1
diw_37	23	5.20	0
diw_38	104	28.98	0
diw_43	15	6.17	0
diw_44	15	6.98	0
diw_46	1241	802.74	9
diw_48	1360	1061.68	10
2g_6_701_k4_9_9	39	8.81	2
2g_7_77_k3_16_17	1948	1962.82	97
2pm_5_55_k6_4_5	169	4.55	1
3g_244_244_k2_16_16	79	16.27	0

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name	# nodes	time	# conss
clique_60_k20_3_3	11	6.76	0
clique_60_k6_10_10	19	23.42	0
2g_6_701_k5_7_8	376	67.99	18
3g_244_244_k3_10_11	98	19.32	0
3pm_234_234_k5_5_6	400	12.95	0
clique_60_k7_8_9	178	284.30	3
2g_6_701_k10_3_4	83	15.21	0
3g_244_244_k4_8_8	159	20.86	0
clique_60_k8_7_8	328	499.29	6
2g_6_701_k7_5_6	72	15.16	0
clique_60_k9_6_7	425	497.20	13
2g_6_701_k2_18_18	139	48.97	0
2g_6_701_k8_4_5	134	28.16	1
3g_244_244_k6_5_6	172	20.89	5
clique_60_k10_6_6	51	76.25	2
clique_60_k4_15_15	9	13.94	0
clique_70_k3_23_24	19	117.90	0
2g_6_701_k3_12_12	285	75.04	10
2g_6_701_k9_4_4	909	119.19	85
clique_60_k15_4_4	34	50.46	0
clique_60_k5_12_12	19	29.17	0
4x5_2bars	16 003	381.60	127
bridge_2x9_2bars	18 395	251.90	80
bridge_3x9_2bars	105 427	3600.00	199
2x5_1scen_6bars	14 348	99.25	85
3x4_1scen_4bars	13 093	86.81	112
5x5_1bar	107 314	3600.00	454
bridge_2x9_2bars_nominal	6366	85.21	166
demonst_1bar_3scen	242 038	3600.00	155
2x4_2scen_3bars	6491	27.69	35
3x3_2scen_6bars	3272	19.38	47
3x4_1scen_6bars	4758	110.57	14
bridge_2x10_2bars_2scen	176 744	3600.01	17
demonst_2bars_2scen	94 651	1159.63	35
test_bridge2	5187	25.78	53
2x5_2scen_3bars	6420	50.08	33
3x3_2scen_8bars	2819	24.99	32
3x4_1scen_8bars	791	29.55	5
demonstsmall_1bar_4scen	13 017	39.47	109
test_bridge3	2386	19.00	10
2x5_2scen_4bars	7525	58.38	40
bridge_2x6_4bars_2scen	37 531	219.82	1397
bridge_3x6_2bars_2scen	25 157	269.22	289
2x5_3bars	5340	42.19	10
3x3_3scen_6bars	10 913	72.99	149
4x3_2bars_3scen	7477	54.00	90
2x4_8bars_2scen	10 146	46.05	157
2x6_3bars	10 336	110.12	15
3x3_3scen_8bars	11 158	67.97	173
4x4_1bar_2scen	367 326	3600.01	10
bridge_2x8_2bars_2scen	38 727	327.23	1915
bridge_3x7_2bars_nominal	9370	138.20	99
2x5_1scen_12bars	7336	99.54	44
2x7_3bars	86 387	1591.87	210
3x3_3scen	19 027	115.04	150
4x4_1bar	10 176	79.27	60
bridge_2x8_2bars_2scen_nominal	13 167	203.31	65

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name	# nodes	time	# conss
bridge_3x8_1bar_2scen	2827	50.04	57
demonstsmall_2bars_2scen	4494	19.34	11
0+-115305C_MISDPld000010	146	4.20	0
0+-115305C_MISDPrd000010	1459	46.12	0
0+-125354B_MISDPld000010	5629	143.51	0
0+-125354B_MISDPrd000010	4665	128.52	0
0+-130403E_MISDPld000010	2775	93.35	0
0+-130403E_MISDPrd000010	771	51.70	0
0+-140605A_MISDPld000010	6645	3600.01	0
0+-140605A_MISDPrd000010	3427	3600.07	0
band40403B_MISDPld000010	103	21.00	0
band40403B_MISDPrd000010	83	15.20	0
band60605D_MISDPld000010	16	35.80	0
band60605D_MISDPrd000010	11	31.86	0
band70704A_MISDPld000010	4128	2739.91	1
band70704A_MISDPrd000010	55	228.74	0
bern15305D_MISDPld000010	17 243	221.21	0
bern15305D_MISDPrd000010	1053	37.96	0
bern25354A_MISDPld000010	8437	179.41	68
bern25354A_MISDPrd000010	5347	137.65	114
bern30403C_MISDPld000010	3097	98.20	12
bern30403C_MISDPrd000010	3503	100.74	2
bern40605A_MISDPld000010	6336	3600.02	0
bern40605A_MISDPrd000010	3460	3600.06	0
bina15305D_MISDPld000010	20 143	263.65	0
bina15305D_MISDPrd000010	78 154	639.76	0
bina25354E_MISDPld000010	12 891	243.07	0
bina25354E_MISDPrd000010	47 619	412.72	0
bina30403B_MISDPld000010	5669	134.61	0
bina30403B_MISDPrd000010	13 699	149.08	1
bina40605B_MISDPld000010	5452	3600.02	0
bina40605B_MISDPrd000010	3560	3600.02	0
norm15305B_MISDPld000010	18 896	253.59	0
norm15305B_MISDPrd000010	1147	45.42	0
norm25354A_MISDPld000010	7061	180.52	0
norm25354A_MISDPrd000010	907	57.31	0
norm30403D_MISDPld000010	3179	109.19	0
norm30403D_MISDPrd000010	1761	84.48	0
norm40605D_MISDPld000010	5560	3600.03	0
norm40605D_MISDPrd000010	2978	3600.04	0
wish15305A_MISDPld000010	18 781	234.43	0
wish15305A_MISDPrd000010	1625	52.40	0
wish25354C_MISDPld000010	6179	150.83	0
wish25354C_MISDPrd000010	2257	86.78	0
wish30403D_MISDPld000010	2777	93.26	0
wish30403D_MISDPrd000010	459	39.44	0
wish40605E_MISDPld000010	6583	3600.04	0
wish40605E_MISDPrd000010	3403	3600.05	0
randomMISDP_120_120_120_0.1	78	335.56	0
randomMISDP_120_120_120_10	105	652.19	0
randomMISDP_120_90_90_0.1	62	302.30	0
randomMISDP_120_90_90_10	82	258.17	0
randomMISDP_60_90_90_10	153	104.81	5
randomMISDP_90_120_90_0.1	88	165.62	0
randomMISDP_90_120_90_10	153	308.63	0
randomMISDP_90_60_90_10	42	56.73	0
randomMISDP_90_90_120_0.1	74	128.65	0

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name	# nodes	time	# conss
randomMISDP_90_90_120_10	91	193.48	0
randomMISDP_90_90_60_10	74	83.69	0
randomMISDP_90_90_90_0.1	62	98.24	0
randomMISDP_90_90_90_10	83	133.66	0
randomMISDP_PSD_120_120_120_0.1	142	2217.15	0
randomMISDP_PSD_120_120_120_10	145	1580.09	0
randomMISDP_PSD_120_90_90_0.1	106	451.92	51
randomMISDP_PSD_120_90_90_10	119	964.90	33
randomMISDP_PSD_60_90_90_10	107	87.74	0
randomMISDP_PSD_90_120_90_0.1	140	438.01	0
randomMISDP_PSD_90_120_90_10	143	479.04	0
randomMISDP_PSD_90_60_90_10	73	160.25	0
randomMISDP_PSD_90_90_120_0.1	104	268.06	0
randomMISDP_PSD_90_90_120_10	107	332.23	0
randomMISDP_PSD_90_90_60_10	127	346.36	50
randomMISDP_PSD_90_90_90_0.1	104	309.25	0
randomMISDP_PSD_90_90_90_10	109	290.44	0

Table 4: Detailed statistics for each instance and **“feas” settings**.

name	# nodes	time	# conss
coloncancer_101_200_7	4879	524.69	4285
coloncancer_201_300_9	1993	277.74	1849
coloncancer_301_400_11	4631	608.82	4081
coloncancer_401_500_13	173	27.09	182
coloncancer_501_600_15	137	24.61	139
coloncancer_601_700_17	1480	192.80	1357
coloncancer_701_800_19	1072	136.96	989
coloncancer_801_900_21	7338	829.11	6501
coloncancer_901_1000_23	14 925	2118.90	14 009
coloncancer_1001_1100_6	347	49.49	325
coloncancer_1101_1200_8	1689	215.40	1473
coloncancer_1201_1300_10	4431	573.29	4047
coloncancer_1301_1400_12	6501	999.03	5551
coloncancer_1401_1500_14	1375	183.20	1258
coloncancer_1501_1600_16	785	116.09	721
coloncancer_1601_1700_18	21 776	3600.00	27 323
coloncancer_1701_1800_20	31 090	3346.56	26 600
coloncancer_1801_1900_22	4025	482.13	3775
coloncancer_1901_2000_24	781	137.40	733
random_64_6_a	1	13.61	4
random_64_6_b	1	13.58	4
random_64_6_c	1	13.36	4
random_64_8_a	1	29.65	4
random_64_8_b	1	31.06	4
random_64_8_c	1	31.04	4
random_96_4_a	1	18.00	4
random_96_4_b	1	18.29	4
random_96_4_c	1	17.92	4
random_96_6_a	1	51.40	4
random_96_6_b	1	53.99	4
random_96_6_c	1	51.49	4
random_96_8_a	1	112.07	4
random_96_8_b	1	106.56	4
random_96_8_c	1	106.76	4
random_128_2_a	9	36.29	18
random_128_2_b	12	28.61	12
random_128_2_c	15	45.40	21
random_128_4_a	1	52.37	4
random_128_4_b	1	55.06	4
random_128_4_c	1	61.67	6
random_128_6_a	1	149.64	4
random_128_6_b	1	153.84	4
random_128_6_c	1	154.53	4
diw_34	13	1.81	15
diw_37	23	5.32	27
diw_38	103	30.60	139
diw_43	15	6.11	15
diw_44	15	6.96	15
diw_46	1241	804.06	1362
diw_48	1360	1069.10	1605
2g_6_701_k4_9_9	39	8.78	49
2g_7_77_k3_16_17	1948	1967.07	898
2pm_5_55_k6_4_5	169	4.69	149
3g_244_244_k2_16_16	79	15.47	90

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name	# nodes	time	# conss
clique_60_k20_3_3	12	7.96	15
clique_60_k6_10_10	19	23.38	39
2g_6_701_k5_7_8	380	67.77	341
3g_244_244_k3_10_11	98	19.43	143
3pm_234_234_k5_5_6	400	13.05	400
clique_60_k7_8_9	178	286.38	230
2g_6_701_k10_3_4	83	15.40	99
3g_244_244_k4_8_8	159	20.82	182
clique_60_k8_7_8	295	308.99	520
2g_6_701_k7_5_6	72	15.12	72
clique_60_k9_6_7	418	415.96	678
2g_6_701_k2_18_18	141	48.34	164
2g_6_701_k8_4_5	127	25.66	135
3g_244_244_k6_5_6	172	21.13	244
clique_60_k10_6_6	51	76.79	57
clique_60_k4_15_15	9	13.92	13
clique_70_k3_23_24	19	118.20	26
2g_6_701_k3_12_12	275	68.53	328
2g_6_701_k9_4_4	949	118.57	1123
clique_60_k15_4_4	34	50.81	34
clique_60_k5_12_12	19	29.17	36
4x5_2bars	17 845	383.71	15 307
bridge_2x9_2bars	17 693	224.04	23 323
bridge_3x9_2bars	110 106	3600.00	165 671
2x5_1scen_6bars	10 648	71.44	9379
3x4_1scen_4bars	13 097	85.23	11 997
5x5_1bar	90 349	3600.00	39 177
bridge_2x9_2bars_nominal	7114	92.10	7062
demonst_1bar_3scen	211 187	3600.00	327 502
2x4_2scen_3bars	4791	20.36	3186
3x3_2scen_6bars	3108	17.05	2930
3x4_1scen_6bars	3100	77.59	2222
bridge_2x10_2bars_2scen	215 006	3600.01	222 989
demonst_2bars_2scen	92 265	1218.64	96 264
test_bridge2	5092	26.19	3731
2x5_2scen_3bars	5260	37.05	5210
3x3_2scen_8bars	2463	14.29	2309
3x4_1scen_8bars	437	5.33	391
demonstsmall_1bar_4scen	12 036	46.75	9364
test_bridge3	1151	6.85	1238
2x5_2scen_4bars	6227	39.09	5985
bridge_2x6_4bars_2scen	37 536	223.20	37 180
bridge_3x6_2bars_2scen	25 262	271.99	27 904
2x5_3bars	2195	14.40	1876
3x3_3scen_6bars	9096	51.49	6955
4x3_2bars_3scen	7504	56.37	9052
2x4_8bars_2scen	10 146	53.30	7133
2x6_3bars	8074	79.60	6149
3x3_3scen_8bars	9015	46.53	7835
4x4_1bar_2scen	304 017	3600.00	305 591
bridge_2x8_2bars_2scen	38 733	331.34	35 819
bridge_3x7_2bars_nominal	9370	143.06	12 665
2x5_1scen_12bars	6364	74.01	7170
2x7_3bars	74 518	1243.01	73 513
3x3_3scen	17 557	94.15	11 297
4x4_1bar	11 004	99.97	8178
bridge_2x8_2bars_2scen_nominal	10 955	150.83	14 116

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name	# nodes	time	# conss
bridge_3x8_1bar_2scen	2817	50.77	3671
demonstsmall_2bars_2scen	2848	13.30	2459
0+-115305C_MISDPld000010	146	4.47	386
0+-115305C_MISDPrd000010	1459	48.36	2865
0+-125354B_MISDPld000010	5629	150.91	11 085
0+-125354B_MISDPrd000010	4665	134.01	9207
0+-130403E_MISDPld000010	2775	96.73	5256
0+-130403E_MISDPrd000010	771	52.50	1391
0+-140605A_MISDPld000010	6581	3600.00	18 849
0+-140605A_MISDPrd000010	3410	3600.04	6953
band40403B_MISDPld000010	103	21.10	173
band40403B_MISDPrd000010	83	15.26	137
band60605D_MISDPld000010	16	36.01	58
band60605D_MISDPrd000010	11	31.87	28
band70704A_MISDPld000010	2776	2068.95	6454
band70704A_MISDPrd000010	55	228.72	110
bern15305D_MISDPld000010	17 243	231.36	34 404
bern15305D_MISDPrd000010	1053	39.52	2080
bern25354A_MISDPld000010	8437	188.82	16 377
bern25354A_MISDPrd000010	5347	143.55	9977
bern30403C_MISDPld000010	3097	100.98	4784
bern30403C_MISDPrd000010	3503	103.40	5276
bern40605A_MISDPld000010	6287	3600.01	17 627
bern40605A_MISDPrd000010	3445	3600.02	7074
bina15305D_MISDPld000010	20 207	275.80	40 407
bina15305D_MISDPrd000010	78 154	680.27	154 141
bina25354E_MISDPld000010	12 891	253.59	25 564
bina25354E_MISDPrd000010	47 619	438.99	94 873
bina30403B_MISDPld000010	5669	141.07	10 892
bina30403B_MISDPrd000010	13 699	157.17	26 741
bina40605B_MISDPld000010	5421	3600.05	14 672
bina40605B_MISDPrd000010	3548	3600.03	7412
norm15305B_MISDPld000010	18 898	264.37	37 751
norm15305B_MISDPrd000010	1147	47.27	2269
norm25354A_MISDPld000010	7061	188.09	13 958
norm25354A_MISDPrd000010	907	58.67	1747
norm30403D_MISDPld000010	3179	112.90	6018
norm30403D_MISDPrd000010	1761	86.48	3293
norm40605D_MISDPld000010	5510	3600.03	15 463
norm40605D_MISDPrd000010	2968	3600.05	5648
wish15305A_MISDPld000010	18 755	246.98	37 675
wish15305A_MISDPrd000010	1625	54.70	3213
wish25354C_MISDPld000010	6179	159.02	12 247
wish25354C_MISDPrd000010	2257	89.93	4417
wish30403D_MISDPld000010	2777	96.68	5254
wish30403D_MISDPrd000010	459	40.01	810
wish40605E_MISDPld000010	6539	3600.00	18 896
wish40605E_MISDPrd000010	3389	3600.02	6883
randomMISDP_120_120_120_0.1	78	337.46	128
randomMISDP_120_120_120_10	105	649.83	163
randomMISDP_120_90_90_0.1	62	302.75	100
randomMISDP_120_90_90_10	82	258.60	123
randomMISDP_60_90_90_10	153	105.20	318
randomMISDP_90_120_90_0.1	88	165.04	144
randomMISDP_90_120_90_10	153	314.90	303
randomMISDP_90_60_90_10	42	56.87	90
randomMISDP_90_90_120_0.1	74	128.67	116

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name	# nodes	time	# conss
randomMISDP_90_90_120_10	91	194.97	186
randomMISDP_90_90_60_10	74	83.19	154
randomMISDP_90_90_90_0.1	62	98.08	98
randomMISDP_90_90_90_10	83	134.82	174
randomMISDP_PSD_120_120_120_0.1	142	2259.68	283
randomMISDP_PSD_120_120_120_10	145	1594.67	308
randomMISDP_PSD_120_90_90_0.1	106	451.48	160
randomMISDP_PSD_120_90_90_10	119	967.12	202
randomMISDP_PSD_60_90_90_10	107	88.28	229
randomMISDP_PSD_90_120_90_0.1	140	439.36	281
randomMISDP_PSD_90_120_90_10	143	480.20	304
randomMISDP_PSD_90_60_90_10	73	160.54	158
randomMISDP_PSD_90_90_120_0.1	104	269.50	209
randomMISDP_PSD_90_90_120_10	107	333.58	232
randomMISDP_PSD_90_90_60_10	127	346.30	186
randomMISDP_PSD_90_90_90_0.1	104	314.91	210
randomMISDP_PSD_90_90_90_10	109	290.65	235

Table 5: Detailed statistics for each instance and **"feas-obj" settings**.

name	# nodes	time	# conss
coloncancer_101_200_7	4827	480.58	4244
coloncancer_201_300_9	1981	269.50	1850
coloncancer_301_400_11	4565	571.70	4023
coloncancer_401_500_13	173	27.20	181
coloncancer_501_600_15	137	25.34	144
coloncancer_601_700_17	1561	222.62	1452
coloncancer_701_800_19	1070	135.63	987
coloncancer_801_900_21	7162	804.38	6361
coloncancer_901_1000_23	14 833	2118.35	13 835
coloncancer_1001_1100_6	351	50.15	340
coloncancer_1101_1200_8	1719	234.49	1535
coloncancer_1201_1300_10	4575	602.66	4164
coloncancer_1301_1400_12	6885	1046.89	5876
coloncancer_1401_1500_14	1387	196.70	1284
coloncancer_1501_1600_16	814	128.35	756
coloncancer_1601_1700_18	24 373	3600.00	28 245
coloncancer_1701_1800_20	31 451	3391.69	26 839
coloncancer_1801_1900_22	4035	495.57	3745
coloncancer_1901_2000_24	1156	218.16	1128
random_64_6_a	1	13.91	4
random_64_6_b	1	13.86	4
random_64_6_c	1	13.61	4
random_64_8_a	1	30.14	4
random_64_8_b	1	31.65	4
random_64_8_c	1	31.64	4
random_96_4_a	1	23.41	5
random_96_4_b	1	18.78	4
random_96_4_c	1	18.27	4
random_96_6_a	1	52.81	4
random_96_6_b	1	55.77	4
random_96_6_c	1	52.83	4
random_96_8_a	1	116.09	4
random_96_8_b	1	109.12	4
random_96_8_c	1	108.91	4
random_128_2_a	9	36.12	17
random_128_2_b	11	27.91	18
random_128_2_c	15	45.55	21
random_128_4_a	1	53.80	4
random_128_4_b	1	56.28	4
random_128_4_c	1	68.86	5
random_128_6_a	1	150.68	4
random_128_6_b	1	155.56	4
random_128_6_c	1	158.34	4
diw_34	7	0.90	6
diw_37	25	4.72	25
diw_38	104	29.50	133
diw_43	15	5.86	15
diw_44	15	6.56	15
diw_46	1171	730.02	1220
diw_48	1231	873.46	1216
2g_6_701_k4_9_9	39	8.82	49
2g_7_77_k3_16_17	1917	2114.66	863
2pm_5_55_k6_4_5	143	4.33	123
3g_244_244_k2_16_16	79	15.84	92

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name	# nodes	time	# conss
clique_60_k20_3_3	5	5.33	5
clique_60_k6_10_10	19	18.65	28
2g_6_701_k5_7_8	376	72.30	337
3g_244_244_k3_10_11	98	19.53	143
3pm_234_234_k5_5_6	400	16.17	400
clique_60_k7_8_9	162	273.31	193
2g_6_701_k10_3_4	83	15.49	99
3g_244_244_k4_8_8	159	21.06	182
clique_60_k8_7_8	290	479.20	329
2g_6_701_k7_5_6	72	15.38	72
clique_60_k9_6_7	345	463.03	427
2g_6_701_k2_18_18	139	48.93	165
2g_6_701_k8_4_5	135	27.48	138
3g_244_244_k6_5_6	172	21.50	249
clique_60_k10_6_6	49	64.21	52
clique_60_k4_15_15	9	13.72	13
clique_70_k3_23_24	19	118.22	26
2g_6_701_k3_12_12	285	75.70	362
2g_6_701_k9_4_4	1103	133.81	1413
clique_60_k15_4_4	34	50.76	34
clique_60_k5_12_12	19	26.68	31
4x5_2bars	15 815	565.21	12 454
bridge_2x9_2bars	17 417	237.59	22 429
bridge_3x9_2bars	110 654	3600.00	162 102
2x5_1scen_6bars	6176	45.45	6080
3x4_1scen_4bars	4917	32.45	4873
5x5_1bar	22 302	3600.00	21 253
bridge_2x9_2bars_nominal	6922	90.71	6695
demonst_1bar_3scen	307 297	3600.00	348 466
2x4_2scen_3bars	4867	23.19	2735
3x3_2scen_6bars	1636	10.86	1603
3x4_1scen_6bars	6041	165.75	5094
bridge_2x10_2bars_2scen	185 102	3600.01	221 525
demonst_2bars_2scen	96 774	1274.32	97 074
test_bridge2	3012	14.79	1730
2x5_2scen_3bars	5796	50.99	5171
3x3_2scen_8bars	1081	12.89	1137
3x4_1scen_8bars	449	20.95	500
demonstsmall_1bar_4scen	12 992	58.67	8839
test_bridge3	2480	17.36	1595
2x5_2scen_4bars	6574	63.93	5152
bridge_2x6_4bars_2scen	30 401	170.21	27 550
bridge_3x6_2bars_2scen	22 579	251.42	24 359
2x5_3bars	2156	15.95	1579
3x3_3scen_6bars	8078	47.96	6492
4x3_2bars_3scen	6429	49.15	7426
2x4_8bars_2scen	11 272	58.68	6090
2x6_3bars	10 406	167.83	7172
3x3_3scen_8bars	7772	50.79	5797
4x4_1bar_2scen	139 930	3600.00	138 933
bridge_2x8_2bars_2scen	40 977	359.94	33 100
bridge_3x7_2bars_nominal	8898	129.73	11 620
2x5_1scen_12bars	3748	45.65	3743
2x7_3bars	60 123	1084.08	53 611
3x3_3scen	25 423	185.33	16 856
4x4_1bar	10 172	142.22	7731
bridge_2x8_2bars_2scen_nominal	11 280	158.96	11 969

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name	# nodes	time	# conss
bridge_3x8_1bar_2scen	2634	47.57	3261
demonstsmall_2bars_2scen	4640	24.70	3945
0+-115305C_MISDPld000010	146	4.41	329
0+-115305C_MISDPrd000010	1459	48.41	2373
0+-125354B_MISDPld000010	5629	155.65	7612
0+-125354B_MISDPrd000010	4665	135.27	6252
0+-130403E_MISDPld000010	2775	98.80	2860
0+-130403E_MISDPrd000010	771	53.17	844
0+-140605A_MISDPld000010	6504	3600.07	17 883
0+-140605A_MISDPrd000010	3344	3600.05	6680
band40403B_MISDPld000010	103	21.10	163
band40403B_MISDPrd000010	83	15.10	115
band60605D_MISDPld000010	128	202.33	569
band60605D_MISDPrd000010	11	30.80	28
band70704A_MISDPld000010	118	228.62	361
band70704A_MISDPrd000010	55	231.08	106
bern15305D_MISDPld000010	17 243	238.98	32 282
bern15305D_MISDPrd000010	1053	39.52	1692
bern25354A_MISDPld000010	8437	197.32	11 822
bern25354A_MISDPrd000010	5347	146.95	7147
bern30403C_MISDPld000010	3097	104.00	3032
bern30403C_MISDPrd000010	3503	106.86	3293
bern40605A_MISDPld000010	6300	3600.04	16 761
bern40605A_MISDPrd000010	3381	3600.04	6534
bina15305D_MISDPld000010	20 191	292.08	37 720
bina15305D_MISDPrd000010	78 154	750.44	139 356
bina25354E_MISDPld000010	12 891	267.49	22 209
bina25354E_MISDPrd000010	47 619	456.35	84 769
bina30403B_MISDPld000010	5669	147.28	8332
bina30403B_MISDPrd000010	13 699	163.72	15 009
bina40605B_MISDPld000010	5378	3600.04	14 414
bina40605B_MISDPrd000010	3465	3600.01	7163
norm15305B_MISDPld000010	18 894	274.71	34 986
norm15305B_MISDPrd000010	1147	47.69	1923
norm25354A_MISDPld000010	7063	198.82	9833
norm25354A_MISDPrd000010	907	58.92	1348
norm30403D_MISDPld000010	3179	114.49	3324
norm30403D_MISDPrd000010	1761	87.64	1752
norm40605D_MISDPld000010	5461	3600.04	14 535
norm40605D_MISDPrd000010	2922	3600.02	5466
wish15305A_MISDPld000010	18 755	268.66	34 640
wish15305A_MISDPrd000010	1625	55.22	2641
wish25354C_MISDPld000010	6179	166.13	8937
wish25354C_MISDPrd000010	2257	91.77	3202
wish30403D_MISDPld000010	2777	99.21	2858
wish30403D_MISDPrd000010	459	40.33	544
wish40605E_MISDPld000010	6468	3600.00	17 899
wish40605E_MISDPrd000010	3334	3600.04	6570
randomMISDP_120_120_120_0.1	78	337.15	128
randomMISDP_120_120_120_10	105	654.18	163
randomMISDP_120_90_90_0.1	62	302.24	100
randomMISDP_120_90_90_10	82	257.75	123
randomMISDP_60_90_90_10	153	105.48	318
randomMISDP_90_120_90_0.1	88	165.71	144
randomMISDP_90_120_90_10	153	315.58	303
randomMISDP_90_60_90_10	42	57.12	90
randomMISDP_90_90_120_0.1	74	128.78	116

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name	# nodes	time	# conss
randomMISDP_90_90_120_10	91	195.32	186
randomMISDP_90_90_60_10	74	83.00	154
randomMISDP_90_90_90_0.1	62	98.36	98
randomMISDP_90_90_90_10	83	135.27	174
randomMISDP_PSD_120_120_120_0.1	142	2223.14	283
randomMISDP_PSD_120_120_120_10	145	1587.12	308
randomMISDP_PSD_120_90_90_0.1	106	452.30	160
randomMISDP_PSD_120_90_90_10	119	965.01	201
randomMISDP_PSD_60_90_90_10	107	88.14	229
randomMISDP_PSD_90_120_90_0.1	140	440.14	281
randomMISDP_PSD_90_120_90_10	143	479.50	304
randomMISDP_PSD_90_60_90_10	73	160.91	158
randomMISDP_PSD_90_90_120_0.1	104	269.11	209
randomMISDP_PSD_90_90_120_10	107	333.59	232
randomMISDP_PSD_90_90_60_10	127	345.52	178
randomMISDP_PSD_90_90_90_0.1	104	313.68	210
randomMISDP_PSD_90_90_90_10	109	290.51	235

Table 6: Detailed statistics for each instance and **"both" settings**.

name	# nodes	time	# conss
coloncancer_101_200_7	4883	522.28	10 496
coloncancer_201_300_9	1987	276.16	4582
coloncancer_301_400_11	2433	369.83	4689
coloncancer_401_500_13	129	23.23	311
coloncancer_501_600_15	117	21.65	287
coloncancer_601_700_17	1330	161.97	2870
coloncancer_701_800_19	795	108.87	1824
coloncancer_801_900_21	4272	468.08	7710
coloncancer_901_1000_23	12 977	1617.01	31 311
coloncancer_1001_1100_6	333	49.13	782
coloncancer_1101_1200_8	1617	213.79	3242
coloncancer_1201_1300_10	3817	500.11	8781
coloncancer_1301_1400_12	5173	753.89	11 228
coloncancer_1401_1500_14	1063	135.85	2340
coloncancer_1501_1600_16	617	96.17	1421
coloncancer_1601_1700_18	23 199	3600.00	65 829
coloncancer_1701_1800_20	30 399	3314.49	68 095
coloncancer_1801_1900_22	3429	418.43	7966
coloncancer_1901_2000_24	361	75.64	818
random_64_6_a	1	13.62	4
random_64_6_b	1	13.59	4
random_64_6_c	1	13.35	4
random_64_8_a	1	29.69	4
random_64_8_b	1	31.10	4
random_64_8_c	1	30.95	4
random_96_4_a	1	18.06	4
random_96_4_b	1	18.29	4
random_96_4_c	1	17.90	4
random_96_6_a	1	51.35	4
random_96_6_b	1	54.09	4
random_96_6_c	1	51.40	4
random_96_8_a	1	111.92	4
random_96_8_b	1	106.64	4
random_96_8_c	1	106.07	4
random_128_2_a	9	36.04	26
random_128_2_b	12	28.63	26
random_128_2_c	15	45.46	39
random_128_4_a	1	52.39	4
random_128_4_b	1	54.91	4
random_128_4_c	1	61.77	6
random_128_6_a	1	147.62	4
random_128_6_b	1	152.23	4
random_128_6_c	1	153.81	4
diw_34	13	1.79	16
diw_37	23	5.34	27
diw_38	103	30.47	139
diw_43	15	6.19	15
diw_44	15	6.97	15
diw_46	1241	803.12	1372
diw_48	1360	1068.29	1614
2g_6_701_k4_9_9	39	8.79	49
2g_7_77_k3_16_17	1948	1964.30	995
2pm_5_55_k6_4_5	169	4.66	150
3g_244_244_k2_16_16	79	15.40	90

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name	# nodes	time	# conss
clique_60_k20_3_3	12	7.98	15
clique_60_k6_10_10	19	23.40	39
2g_6_701_k5_7_8	380	67.92	357
3g_244_244_k3_10_11	98	19.46	143
3pm_234_234_k5_5_6	400	13.15	400
clique_60_k7_8_9	178	286.05	233
2g_6_701_k10_3_4	83	15.42	99
3g_244_244_k4_8_8	159	20.83	182
clique_60_k8_7_8	295	309.17	529
2g_6_701_k7_5_6	72	15.24	72
clique_60_k9_6_7	418	415.41	694
2g_6_701_k2_18_18	141	48.46	164
2g_6_701_k8_4_5	127	25.74	136
3g_244_244_k6_5_6	172	21.19	248
clique_60_k10_6_6	51	76.71	59
clique_60_k4_15_15	9	13.86	13
clique_70_k3_23_24	19	118.36	26
2g_6_701_k3_12_12	275	68.49	335
2g_6_701_k9_4_4	949	118.74	1188
clique_60_k15_4_4	34	51.03	34
clique_60_k5_12_12	19	29.32	36
4x5_2bars	17 845	384.87	15 435
bridge_2x9_2bars	17 693	224.05	23 389
bridge_3x9_2bars	109 696	3600.00	165 443
2x5_1scen_6bars	10 648	70.92	9429
3x4_1scen_4bars	13 097	85.77	12 052
5x5_1bar	92 932	3600.00	47 445
bridge_2x9_2bars_nominal	6360	86.03	6684
demonst_1bar_3scen	235 595	3600.00	328 200
2x4_2scen_3bars	4791	20.24	3216
3x3_2scen_6bars	3108	16.62	2945
3x4_1scen_6bars	3100	77.99	2235
bridge_2x10_2bars_2scen	220 062	3600.00	222 787
demonst_2bars_2scen	92 265	1224.83	96 297
test_bridge2	5092	26.79	3756
2x5_2scen_3bars	5260	36.94	5229
3x3_2scen_8bars	2463	14.27	2321
3x4_1scen_8bars	437	5.35	391
demonstsmall_1bar_4scen	8114	32.13	6727
test_bridge3	1151	6.94	1242
2x5_2scen_4bars	6227	38.92	6035
bridge_2x6_4bars_2scen	37 495	222.53	38 440
bridge_3x6_2bars_2scen	25 248	273.02	28 161
2x5_3bars	2195	14.47	1882
3x3_3scen_6bars	9537	59.50	7854
4x3_2bars_3scen	7504	56.44	9110
2x4_8bars_2scen	10 146	52.79	7243
2x6_3bars	8074	80.23	6155
3x3_3scen_8bars	9015	46.95	7945
4x4_1bar_2scen	290 106	3600.00	310 805
bridge_2x8_2bars_2scen	38 719	331.07	37 667
bridge_3x7_2bars_nominal	9370	141.84	12 715
2x5_1scen_12bars	6360	74.24	7180
2x7_3bars	74 508	1243.65	73 627
3x3_3scen	17 557	96.34	11 451
4x4_1bar	11 004	100.32	8247
bridge_2x8_2bars_2scen_nominal	10 955	150.28	14 137

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name	# nodes	time	# conss
bridge_3x8_1bar_2scen	2817	50.72	3704
demonstsmall_2bars_2scen	2848	13.28	2465
0+-115305C_MISDPld000010	146	4.50	410
0+-115305C_MISDPrd000010	1459	48.37	2900
0+-125354B_MISDPld000010	5629	149.15	11 242
0+-125354B_MISDPrd000010	4665	133.78	9333
0+-130403E_MISDPld000010	2775	96.90	5527
0+-130403E_MISDPrd000010	771	52.54	1528
0+-140605A_MISDPld000010	6593	3600.03	18 993
0+-140605A_MISDPrd000010	3409	3600.07	7030
band40403B_MISDPld000010	103	21.13	206
band40403B_MISDPrd000010	83	15.25	162
band60605D_MISDPld000010	16	36.07	66
band60605D_MISDPrd000010	11	31.81	28
band70704A_MISDPld000010	1052	1067.18	2666
band70704A_MISDPrd000010	55	228.66	114
bern15305D_MISDPld000010	17 243	232.55	34 523
bern15305D_MISDPrd000010	1053	39.33	2106
bern25354A_MISDPld000010	8437	188.43	16 615
bern25354A_MISDPrd000010	5347	143.88	10 223
bern30403C_MISDPld000010	3097	101.48	5087
bern30403C_MISDPrd000010	3503	103.56	5581
bern40605A_MISDPld000010	6370	3600.02	18 076
bern40605A_MISDPrd000010	3446	3600.00	7153
bina15305D_MISDPld000010	20 207	274.09	40 522
bina15305D_MISDPrd000010	78 154	673.26	154 321
bina25354E_MISDPld000010	12 891	254.12	25 769
bina25354E_MISDPrd000010	47 619	437.23	95 213
bina30403B_MISDPld000010	5669	141.34	11 311
bina30403B_MISDPrd000010	13 699	157.15	27 359
bina40605B_MISDPld000010	5422	3600.04	14 866
bina40605B_MISDPrd000010	3549	3600.00	7486
norm15305B_MISDPld000010	18 898	262.47	37 875
norm15305B_MISDPrd000010	1147	47.26	2302
norm25354A_MISDPld000010	7061	188.50	14 108
norm25354A_MISDPrd000010	907	58.68	1806
norm30403D_MISDPld000010	3179	113.02	6334
norm30403D_MISDPrd000010	1761	86.17	3502
norm40605D_MISDPld000010	5523	3600.02	15 645
norm40605D_MISDPrd000010	2971	3600.03	5730
wish15305A_MISDPld000010	18 755	246.55	37 805
wish15305A_MISDPrd000010	1625	54.54	3250
wish25354C_MISDPld000010	6179	158.46	12 410
wish25354C_MISDPrd000010	2257	90.00	4503
wish30403D_MISDPld000010	2777	96.80	5529
wish30403D_MISDPrd000010	459	39.98	909
wish40605E_MISDPld000010	6557	3600.03	19 072
wish40605E_MISDPrd000010	3395	3600.00	6977
randomMISDP_120_120_120_0.1	78	338.17	128
randomMISDP_120_120_120_10	105	650.06	163
randomMISDP_120_90_90_0.1	62	302.01	100
randomMISDP_120_90_90_10	82	258.10	123
randomMISDP_60_90_90_10	153	105.61	323
randomMISDP_90_120_90_0.1	88	164.69	144
randomMISDP_90_120_90_10	153	310.30	303
randomMISDP_90_60_90_10	42	57.01	90
randomMISDP_90_90_120_0.1	74	128.61	116

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name	# nodes	time	# conss
randomMISDP_90_90_120_10	91	194.81	186
randomMISDP_90_90_60_10	74	83.25	154
randomMISDP_90_90_90_0.1	62	98.94	98
randomMISDP_90_90_90_10	83	134.69	174
randomMISDP_PSD_120_120_120_0.1	142	2238.01	283
randomMISDP_PSD_120_120_120_10	145	1582.49	308
randomMISDP_PSD_120_90_90_0.1	106	451.66	211
randomMISDP_PSD_120_90_90_10	119	968.14	235
randomMISDP_PSD_60_90_90_10	107	88.77	229
randomMISDP_PSD_90_120_90_0.1	140	440.05	281
randomMISDP_PSD_90_120_90_10	143	480.51	304
randomMISDP_PSD_90_60_90_10	73	161.23	158
randomMISDP_PSD_90_90_120_0.1	104	268.41	209
randomMISDP_PSD_90_90_120_10	107	333.26	232
randomMISDP_PSD_90_90_60_10	127	347.03	236
randomMISDP_PSD_90_90_90_0.1	104	315.00	210
randomMISDP_PSD_90_90_90_10	109	291.20	235

Table 7: Detailed statistics for each instance and **"both-cancel" settings**.

name	# nodes	time	# conss
coloncancer_101_200_7	4843	476.02	10 134
coloncancer_201_300_9	1969	265.00	4451
coloncancer_301_400_11	2433	371.42	4550
coloncancer_401_500_13	129	22.69	310
coloncancer_501_600_15	117	21.83	286
coloncancer_601_700_17	1342	195.37	2852
coloncancer_701_800_19	804	106.83	1817
coloncancer_801_900_21	4316	465.59	7678
coloncancer_901_1000_23	12 989	1620.11	31 271
coloncancer_1001_1100_6	339	49.56	801
coloncancer_1101_1200_8	1627	225.98	3308
coloncancer_1201_1300_10	4001	518.92	9015
coloncancer_1301_1400_12	5387	795.88	11 390
coloncancer_1401_1500_14	1071	137.68	2401
coloncancer_1501_1600_16	641	102.62	1477
coloncancer_1601_1700_18	26 021	3600.00	68 282
coloncancer_1701_1800_20	29 722	3177.95	66 096
coloncancer_1801_1900_22	3340	409.67	7601
coloncancer_1901_2000_24	539	112.42	1187
random_64_6_a	1	13.89	4
random_64_6_b	1	13.96	4
random_64_6_c	1	13.57	4
random_64_8_a	1	30.12	4
random_64_8_b	1	31.70	4
random_64_8_c	1	31.67	4
random_96_4_a	1	23.27	5
random_96_4_b	1	18.73	4
random_96_4_c	1	18.30	4
random_96_6_a	1	52.65	4
random_96_6_b	1	55.26	4
random_96_6_c	1	52.70	4
random_96_8_a	1	115.08	4
random_96_8_b	1	108.20	4
random_96_8_c	1	108.83	4
random_128_2_a	9	36.15	25
random_128_2_b	11	27.61	29
random_128_2_c	15	45.40	39
random_128_4_a	1	53.76	4
random_128_4_b	1	56.37	4
random_128_4_c	1	68.80	5
random_128_6_a	1	151.47	4
random_128_6_b	1	154.78	4
random_128_6_c	1	158.04	4
diw_34	13	1.79	16
diw_37	23	5.45	27
diw_38	103	30.61	139
diw_43	15	6.26	15
diw_44	15	6.98	15
diw_46	1241	799.21	1372
diw_48	1360	1067.13	1614
2g_6_701_k4_9_9	39	8.87	49
2g_7_77_k3_16_17	1948	1971.40	995
2pm_5_55_k6_4_5	169	4.67	150
3g_244_244_k2_16_16	79	15.45	90

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name	# nodes	time	# conss
clique_60_k20_3_3	12	7.98	15
clique_60_k6_10_10	19	23.38	39
2g_6_701_k5_7_8	380	67.97	357
3g_244_244_k3_10_11	98	19.41	143
3pm_234_234_k5_5_6	400	13.18	400
clique_60_k7_8_9	178	286.24	233
2g_6_701_k10_3_4	83	15.37	99
3g_244_244_k4_8_8	159	20.80	182
clique_60_k8_7_8	295	308.62	529
2g_6_701_k7_5_6	72	15.12	72
clique_60_k9_6_7	418	416.14	694
2g_6_701_k2_18_18	141	48.30	164
2g_6_701_k8_4_5	127	25.68	136
3g_244_244_k6_5_6	172	21.15	248
clique_60_k10_6_6	51	76.64	59
clique_60_k4_15_15	9	13.94	13
clique_70_k3_23_24	19	118.18	26
2g_6_701_k3_12_12	275	68.51	335
2g_6_701_k9_4_4	949	118.71	1188
clique_60_k15_4_4	34	50.81	34
clique_60_k5_12_12	19	29.21	36
4x5_2bars	17 845	384.23	15 435
bridge_2x9_2bars	17 693	224.69	23 389
bridge_3x9_2bars	109 693	3600.00	165 439
2x5_1scen_6bars	10 648	71.20	9429
3x4_1scen_4bars	13 097	85.46	12 052
5x5_1bar	91 381	3600.00	45 297
bridge_2x9_2bars_nominal	6360	85.82	6684
demonst_1bar_3scen	235 747	3600.00	328 366
2x4_2scen_3bars	4791	20.26	3216
3x3_2scen_6bars	3108	16.72	2945
3x4_1scen_6bars	3100	78.46	2235
bridge_2x10_2bars_2scen	219 749	3600.01	222 461
demonst_2bars_2scen	92 265	1226.37	96 297
test_bridge2	5092	26.65	3756
2x5_2scen_3bars	5260	36.71	5229
3x3_2scen_8bars	2463	14.21	2321
3x4_1scen_8bars	437	5.32	391
demonstsmall_1bar_4scen	8114	32.55	6727
test_bridge3	1151	6.91	1242
2x5_2scen_4bars	6227	38.96	6035
bridge_2x6_4bars_2scen	37 495	220.90	38 440
bridge_3x6_2bars_2scen	25 248	272.25	28 161
2x5_3bars	2195	14.52	1882
3x3_3scen_6bars	9537	59.43	7854
4x3_2bars_3scen	7504	56.98	9110
2x4_8bars_2scen	10 146	52.70	7243
2x6_3bars	8074	79.99	6155
3x3_3scen_8bars	9015	46.88	7945
4x4_1bar_2scen	290 104	3600.00	310 802
bridge_2x8_2bars_2scen	38 719	330.65	37 667
bridge_3x7_2bars_nominal	9370	142.38	12 715
2x5_1scen_12bars	6360	74.52	7180
2x7_3bars	74 508	1252.59	73 627
3x3_3scen	17 557	95.91	11 451
4x4_1bar	11 004	99.53	8247
bridge_2x8_2bars_2scen_nominal	10 955	151.04	14 137

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name	# nodes	time	# conss
bridge_3x8_1bar_2scen	2817	50.69	3704
demonstsmall_2bars_2scen	2848	13.21	2465
0+-115305C_MISDPld000010	146	4.26	410
0+-115305C_MISDPrd000010	1459	52.44	2900
0+-125354B_MISDPld000010	5629	164.00	11 242
0+-125354B_MISDPrd000010	4665	162.59	9333
0+-130403E_MISDPld000010	2775	101.00	5527
0+-130403E_MISDPrd000010	771	54.30	1528
0+-140605A_MISDPld000010	6400	3600.03	18 414
0+-140605A_MISDPrd000010	3370	3600.03	6917
band40403B_MISDPld000010	103	21.03	206
band40403B_MISDPrd000010	83	15.28	162
band60605D_MISDPld000010	16	35.95	66
band60605D_MISDPrd000010	11	31.88	28
band70704A_MISDPld000010	1610	1430.22	1233
band70704A_MISDPrd000010	55	228.70	114
bern15305D_MISDPld000010	17 243	287.98	34 523
bern15305D_MISDPrd000010	1053	40.14	2106
bern25354A_MISDPld000010	8437	217.99	16 618
bern25354A_MISDPrd000010	5347	165.44	10 235
bern30403C_MISDPld000010	3097	110.33	5087
bern30403C_MISDPrd000010	3503	114.38	5581
bern40605A_MISDPld000010	5997	3600.06	16 957
bern40605A_MISDPrd000010	3402	3600.06	7020
bina15305D_MISDPld000010	20 143	312.90	40 410
bina15305D_MISDPrd000010	78 154	734.59	154 321
bina25354E_MISDPld000010	12 891	279.53	25 769
bina25354E_MISDPrd000010	47 619	494.31	95 213
bina30403B_MISDPld000010	5669	152.38	11 311
bina30403B_MISDPrd000010	13 699	192.48	27 361
bina40605B_MISDPld000010	5300	3600.02	14 506
bina40605B_MISDPrd000010	3501	3600.05	7342
norm15305B_MISDPld000010	18 896	324.18	37 871
norm15305B_MISDPrd000010	1147	49.45	2302
norm25354A_MISDPld000010	7061	208.77	14 108
norm25354A_MISDPrd000010	907	60.62	1806
norm30403D_MISDPld000010	3179	117.54	6334
norm30403D_MISDPrd000010	1761	94.50	3503
norm40605D_MISDPld000010	5337	3600.02	15 086
norm40605D_MISDPrd000010	2936	3600.05	5627
wish15305A_MISDPld000010	18 781	304.88	37 866
wish15305A_MISDPrd000010	1625	59.88	3250
wish25354C_MISDPld000010	6179	175.38	12 364
wish25354C_MISDPrd000010	2257	105.41	4503
wish30403D_MISDPld000010	2777	101.23	5529
wish30403D_MISDPrd000010	459	40.36	909
wish40605E_MISDPld000010	6361	3600.00	18 484
wish40605E_MISDPrd000010	3356	3600.04	6864
randomMISDP_120_120_120_0.1	78	336.27	167
randomMISDP_120_120_120_10	105	651.15	242
randomMISDP_120_90_90_0.1	62	301.96	130
randomMISDP_120_90_90_10	82	257.87	181
randomMISDP_60_90_90_10	153	105.86	360
randomMISDP_90_120_90_0.1	88	166.27	187
randomMISDP_90_120_90_10	153	310.19	342
randomMISDP_90_60_90_10	42	57.02	92
randomMISDP_90_90_120_0.1	74	128.59	153

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name	# nodes	time	# conss
randomMISDP_90_90_120_10	91	194.92	203
randomMISDP_90_90_60_10	74	83.89	169
randomMISDP_90_90_90_0.1	62	98.22	128
randomMISDP_90_90_90_10	83	135.17	186
randomMISDP_PSD_120_120_120_0.1	142	2223.35	283
randomMISDP_PSD_120_120_120_10	145	1581.62	308
randomMISDP_PSD_120_90_90_0.1	106	453.14	212
randomMISDP_PSD_120_90_90_10	119	964.55	235
randomMISDP_PSD_60_90_90_10	107	88.52	229
randomMISDP_PSD_90_120_90_0.1	140	439.11	281
randomMISDP_PSD_90_120_90_10	143	478.95	304
randomMISDP_PSD_90_60_90_10	73	161.04	158
randomMISDP_PSD_90_90_120_0.1	104	268.44	209
randomMISDP_PSD_90_90_120_10	107	333.67	232
randomMISDP_PSD_90_90_60_10	127	346.75	236
randomMISDP_PSD_90_90_90_0.1	104	313.64	210
randomMISDP_PSD_90_90_90_10	109	291.25	235

Table 8: Detailed statistics for each instance and **"both-cmir" settings**.

name	# nodes	time	# conss
coloncancer_101_200_7	4933	494.57	10 883
coloncancer_201_300_9	2015	268.17	4718
coloncancer_301_400_11	4186	558.43	8718
coloncancer_401_500_13	157	25.80	383
coloncancer_501_600_15	127	23.56	316
coloncancer_601_700_17	1515	208.57	3445
coloncancer_701_800_19	1000	132.93	2386
coloncancer_801_900_21	5332	573.31	10 372
coloncancer_901_1000_23	14 269	2007.16	34 055
coloncancer_1001_1100_6	349	48.99	841
coloncancer_1101_1200_8	1767	234.95	3703
coloncancer_1201_1300_10	4101	523.24	9665
coloncancer_1301_1400_12	7013	1079.23	16 024
coloncancer_1401_1500_14	1279	167.97	2887
coloncancer_1501_1600_16	772	114.43	1764
coloncancer_1601_1700_18	24 435	3600.00	68 272
coloncancer_1701_1800_20	31 689	3457.03	72 515
coloncancer_1801_1900_22	3687	436.11	8614
coloncancer_1901_2000_24	599	115.72	1390
random_64_6_a	1	13.93	4
random_64_6_b	1	13.90	4
random_64_6_c	1	13.59	4
random_64_8_a	1	30.24	4
random_64_8_b	1	31.65	4
random_64_8_c	1	31.70	4
random_96_4_a	1	22.87	5
random_96_4_b	1	18.76	4
random_96_4_c	1	18.35	4
random_96_6_a	1	52.79	4
random_96_6_b	1	55.25	4
random_96_6_c	1	52.67	4
random_96_8_a	1	114.62	4
random_96_8_b	1	109.10	4
random_96_8_c	1	108.94	4
random_128_2_a	9	36.12	25
random_128_2_b	11	27.47	29
random_128_2_c	15	45.36	39
random_128_4_a	1	53.69	4
random_128_4_b	1	56.26	4
random_128_4_c	1	68.53	5
random_128_6_a	1	150.93	4
random_128_6_b	1	154.97	4
random_128_6_c	1	157.16	4
diw_34	13	1.80	16
diw_37	23	5.35	27
diw_38	103	30.72	139
diw_43	15	6.20	15
diw_44	15	7.03	15
diw_46	1241	814.08	1371
diw_48	1360	1079.84	1611
2g_6_701_k4_9_9	39	8.94	49
2g_7_77_k3_16_17	1948	1993.34	995
2pm_5_55_k6_4_5	169	4.77	150
3g_244_244_k2_16_16	79	15.69	90

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name	# nodes	time	# conss
clique_60_k20_3_3	11	6.95	14
clique_60_k6_10_10	19	24.10	39
2g_6_701_k5_7_8	380	69.59	357
3g_244_244_k3_10_11	98	19.84	143
3pm_234_234_k5_5_6	400	13.35	400
clique_60_k7_8_9	178	292.14	233
2g_6_701_k10_3_4	83	15.70	99
3g_244_244_k4_8_8	159	21.33	182
clique_60_k8_7_8	295	319.30	529
2g_6_701_k7_5_6	72	15.42	72
clique_60_k9_6_7	418	428.27	695
2g_6_701_k2_18_18	141	49.07	164
2g_6_701_k8_4_5	127	26.23	136
3g_244_244_k6_5_6	172	21.61	249
clique_60_k10_6_6	51	78.30	59
clique_60_k4_15_15	9	14.16	13
clique_70_k3_23_24	19	119.45	26
2g_6_701_k3_12_12	275	69.68	335
2g_6_701_k9_4_4	951	122.76	1214
clique_60_k15_4_4	34	52.02	34
clique_60_k5_12_12	19	30.06	36
4x5_2bars	17 845	392.40	15 435
bridge_2x9_2bars	17 693	226.99	23 400
bridge_3x9_2bars	106 689	3600.00	162 287
2x5_1scen_6bars	10 648	73.34	9427
3x4_1scen_4bars	13 097	87.82	12 054
5x5_1bar	91 575	3600.00	45 578
bridge_2x9_2bars_nominal	6220	85.56	6578
demonst_1bar_3scen	280 320	3600.00	357 872
2x4_2scen_3bars	4791	20.63	3216
3x3_2scen_6bars	3108	17.10	2945
3x4_1scen_6bars	3100	80.88	2235
bridge_2x10_2bars_2scen	210 976	3600.00	221 312
demonst_2bars_2scen	93 203	1208.54	92 341
test_bridge2	5092	26.80	3756
2x5_2scen_3bars	5264	37.79	5234
3x3_2scen_8bars	2463	15.07	2321
3x4_1scen_8bars	437	5.46	391
demonstsmall_1bar_4scen	8114	32.77	6727
test_bridge3	1151	6.98	1242
2x5_2scen_4bars	6227	39.96	6035
bridge_2x6_4bars_2scen	37 504	226.83	38 423
bridge_3x6_2bars_2scen	25 248	276.09	28 164
2x5_3bars	2195	14.66	1882
3x3_3scen_6bars	9096	52.55	7024
4x3_2bars_3scen	7506	57.26	9113
2x4_8bars_2scen	10 146	54.28	7243
2x6_3bars	8074	81.80	6155
3x3_3scen_8bars	9015	48.01	7945
4x4_1bar_2scen	292 250	3600.00	306 810
bridge_2x8_2bars_2scen	38 715	333.66	37 672
bridge_3x7_2bars_nominal	9370	142.12	12 716
2x5_1scen_12bars	6360	77.61	7181
2x7_3bars	69 394	933.64	70 704
3x3_3scen	17 557	97.33	11 451
4x4_1bar	11 004	100.84	8247
bridge_2x8_2bars_2scen_nominal	10 955	151.10	14 137

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name	# nodes	time	# conss
bridge_3x8_1bar_2scen	2835	51.03	3693
demonstsmall_2bars_2scen	2848	13.42	2465
0+-115305C_MISDPld000010	146	4.51	410
0+-115305C_MISDPrd000010	1459	48.55	2900
0+-125354B_MISDPld000010	5629	152.14	11 242
0+-125354B_MISDPrd000010	4665	134.73	9333
0+-130403E_MISDPld000010	2775	97.33	5527
0+-130403E_MISDPrd000010	771	52.80	1528
0+-140605A_MISDPld000010	6572	3600.08	18 930
0+-140605A_MISDPrd000010	3397	3600.01	6996
band40403B_MISDPld000010	103	21.15	206
band40403B_MISDPrd000010	83	15.33	162
band60605D_MISDPld000010	16	35.96	66
band60605D_MISDPrd000010	11	31.78	28
band70704A_MISDPld000010	951	892.72	2313
band70704A_MISDPrd000010	55	228.66	114
bern15305D_MISDPld000010	17 243	254.58	34 523
bern15305D_MISDPrd000010	1053	44.82	2106
bern25354A_MISDPld000010	8437	191.31	16 615
bern25354A_MISDPrd000010	5347	196.48	10 231
bern30403C_MISDPld000010	3097	101.64	5087
bern30403C_MISDPrd000010	3503	131.13	5581
bern40605A_MISDPld000010	6113	3600.02	17 305
bern40605A_MISDPrd000010	3235	3600.01	6529
bina15305D_MISDPld000010	20 207	278.47	40 522
bina15305D_MISDPrd000010	78 154	687.09	154 321
bina25354E_MISDPld000010	12 891	256.84	25 769
bina25354E_MISDPrd000010	47 619	444.38	95 213
bina30403B_MISDPld000010	5669	142.25	11 311
bina30403B_MISDPrd000010	13 699	158.80	27 359
bina40605B_MISDPld000010	5422	3600.08	14 866
bina40605B_MISDPrd000010	3545	3600.03	7474
norm15305B_MISDPld000010	18 898	266.52	37 875
norm15305B_MISDPrd000010	1147	47.53	2302
norm25354A_MISDPld000010	7061	189.61	14 108
norm25354A_MISDPrd000010	907	58.85	1806
norm30403D_MISDPld000010	3179	113.57	6334
norm30403D_MISDPrd000010	1761	86.53	3502
norm40605D_MISDPld000010	5511	3600.00	15 610
norm40605D_MISDPrd000010	2971	3600.02	5730
wish15305A_MISDPld000010	18 755	247.44	37 805
wish15305A_MISDPrd000010	1625	54.99	3250
wish25354C_MISDPld000010	6179	160.19	12 410
wish25354C_MISDPrd000010	2257	90.44	4503
wish30403D_MISDPld000010	2777	97.28	5529
wish30403D_MISDPrd000010	459	40.06	909
wish40605E_MISDPld000010	6541	3600.02	19 024
wish40605E_MISDPrd000010	3389	3600.02	6959
randomMISDP_120_120_120_0.1	78	338.39	128
randomMISDP_120_120_120_10	105	651.64	163
randomMISDP_120_90_90_0.1	62	302.00	100
randomMISDP_120_90_90_10	82	258.90	123
randomMISDP_60_90_90_10	153	106.12	323
randomMISDP_90_120_90_0.1	88	165.32	144
randomMISDP_90_120_90_10	153	313.39	303
randomMISDP_90_60_90_10	42	56.87	90
randomMISDP_90_90_120_0.1	74	128.83	116

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name	# nodes	time	# conss
randomMISDP_90_90_120_10	91	194.83	186
randomMISDP_90_90_60_10	74	83.66	154
randomMISDP_90_90_90_0.1	62	99.30	98
randomMISDP_90_90_90_10	83	134.79	174
randomMISDP_PSD_120_120_120_0.1	142	2235.67	283
randomMISDP_PSD_120_120_120_10	145	1584.92	308
randomMISDP_PSD_120_90_90_0.1	106	453.14	211
randomMISDP_PSD_120_90_90_10	119	967.07	235
randomMISDP_PSD_60_90_90_10	107	88.21	229
randomMISDP_PSD_90_120_90_0.1	140	438.96	281
randomMISDP_PSD_90_120_90_10	143	478.47	304
randomMISDP_PSD_90_60_90_10	73	160.81	158
randomMISDP_PSD_90_90_120_0.1	104	268.98	209
randomMISDP_PSD_90_90_120_10	107	330.67	232
randomMISDP_PSD_90_90_60_10	127	345.44	236
randomMISDP_PSD_90_90_90_0.1	104	313.17	210
randomMISDP_PSD_90_90_90_10	109	291.88	235