Block Compression and Invariant Pruning for SAT-based Totally-Ordered HTN Planning: Extended Data

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Further Evaluation

This supplement pertains to the ICAPS paper "Block Compression and Invariant Pruning for SAT-based Totally-Ordered HTN Planning" (Behnke 2021). We report further details of the evaluation we have conducted. In Table 1 we report the absolute coverage of all planners on the domains of the IPC 2020 totally-ordered track. In Table 2 we report normalised coverage, i.e. for solving a problem in a domain with p problems the planner gets a score of $\frac{1}{p}$. Normalising the score removes the uneven size of the domains (between 12 for Entertainment and 147 for Elevators-Learned). Lastly, in Table 3 we report the results when computing the IPC score. Here, only the best configuration of our SAT-based planner – pandaPIsatt-1iB – has a higher score than the IPC winner HyperTensioN. This is due to the fact that the IPC score favours planners that find a solution very quickly (the full score is only awarded for solving a problem within one second) and punishes them for taking time to solve a problem. The reason for the stark disparity in coverage (and normalised coverage) and IPC score for HyperTensioN can be seen if we consider the inverted cactus plot shown in Figure. 1. HyperTensioN (orange line) is very quick in solving a lot of problems. Within one second it has already solved 482 problems, while SAT-1iB has solved only 272. SAT-1iB however overtakes HyperTensioN after 52 seconds when both planners have solved 562 instances. HyperTensioN solves only 10 more instances after this point, while SAT-1iB solves 78 more.

Coverage, normalised coverage and IPC score for the comparison with Tree-REX can be found in Tables 4, 5, and 6.

Lastly, we present a per-domain analysis of the strength of unary and binary invariant pruning in Table 7. In the first block, we consider all PDTs constructed by the planner SAT-1iB – 20088 in total. We then provide how many of these were fully pruned using unary invariant pruning, i.e. for which we could show unsolvability. The results vary widely per domain. E.g. in Robot and Towers only a few PDTs are fully pruned, while domains like Blocksworld-GTOHP, Depots, Minecraft-Regular, and Factories-simple seem to be amenable to this techniques. We the also report the amount of leaf pruning, i.e. the percentage of actions that were removed from the leafs of the PDTs. Again this varies widely, with no pruning at all in Childsnack (it seems to be an all-or-nothing, either the whole PDT is pruning or nothing at all) and 85.69 % in Towers (almost no fully pruned PDTs, but a lot of pruning overall) and 89.54% in Monroe-Fully-Observable. The 96.24% in Minecraft-Player is an outlier caused by the small amount of PDTs constructed (26) – for most instances grounding already fails on this domain.

The second block of Table 7 reports the same values for SAT-2iB. In some instances, the amount of leaf pruning *decreases*. This is due to the fact that we compute leaf pruning only with reference to those PDTs that were not fully pruned. Consider, e.g., Transport, where the amount of fully pruned PDTs increases.

Lastly, the third block shows a comparison only on those 14676 PDTs that were constructed by both planners. We first report the amount of fully pruned PDTs by SAT-1iB. Then we report how many *additional* PDTs SAT-2iB pruned. This is given in absolute terms, i.e. for Transport SAT-2iB pruned 81.82% (= 64.94% + 16.88%) of all PDTs. Here we can see a very high dependency on the actual domain. In 14 domains, SAT-2iB could not prune any additional PDTs, while in four domains it could prune more than 13% additionally. In the last column we report for all PDTs that could not be fully pruned by SAT-2iB how many additional actions were pruned from the leafs of the PDT. This is again relative to the overall number of actions assigned to the leafs. In many domains, there is no additional pruning, while some benefit.

In Figures 2 and 3 we present per-domain scatter plots of the effect of block compression and leaf pruning.

References

Behnke, G. 2021. Block Compression and Invariant Pruning for SAT-based Totally-Ordered HTN Planning. In *Proc. of the 31st Int. Conf. on Autom. Plan. and Sched. (ICAPS 2021)*. AAAI Press.

Schreiber, D.; Balyo, T.; Pellier, D.; and Fiorino, H. 2019. Tree-REX: SAT-based Tree Exploration for Efficient and High-Quality HTN Planning. In *Proc. of the 29th Int. Conf. on Autom. Plan. and Sched. (ICAPS 2019)*, 382–390. AAAI Press.

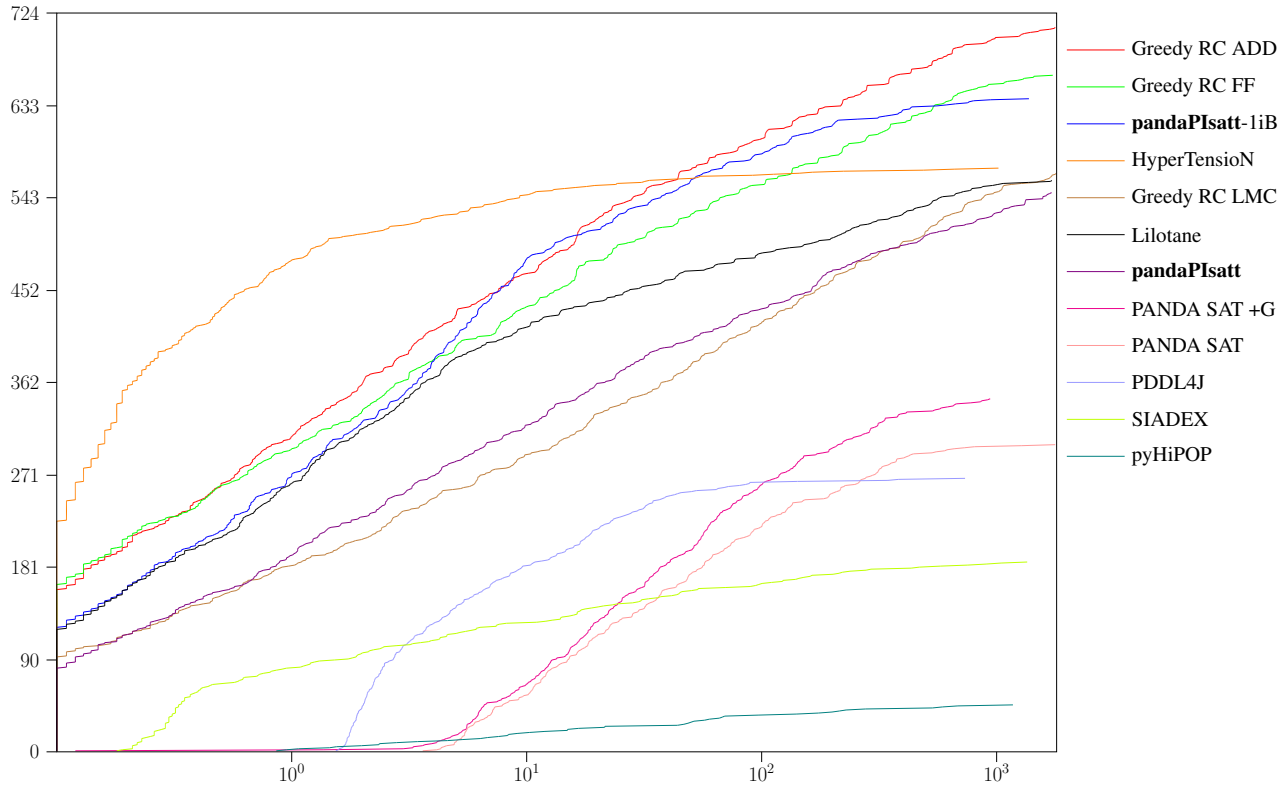

Figure 1: Inverted Cactus Plot showing the runtime necessary to solve a given amount of instances. Runtime in seconds is on the x-axis (log scale). Number of solved instances is on the y-axis. Planners are coded by colour.

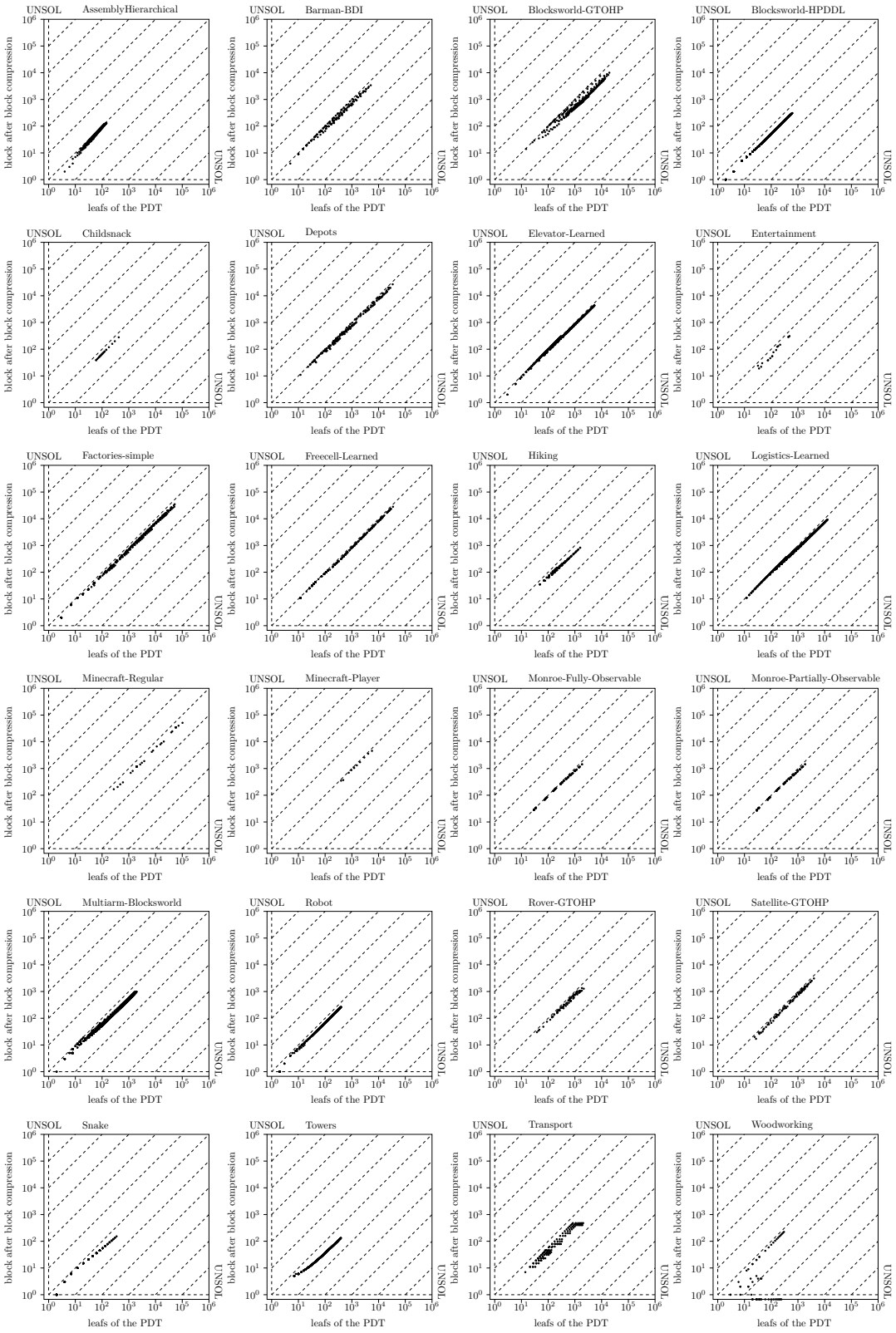

Figure 2: For every PDT created by SAT-MB: The number of leafs of the PDT and of blocks after block compression.

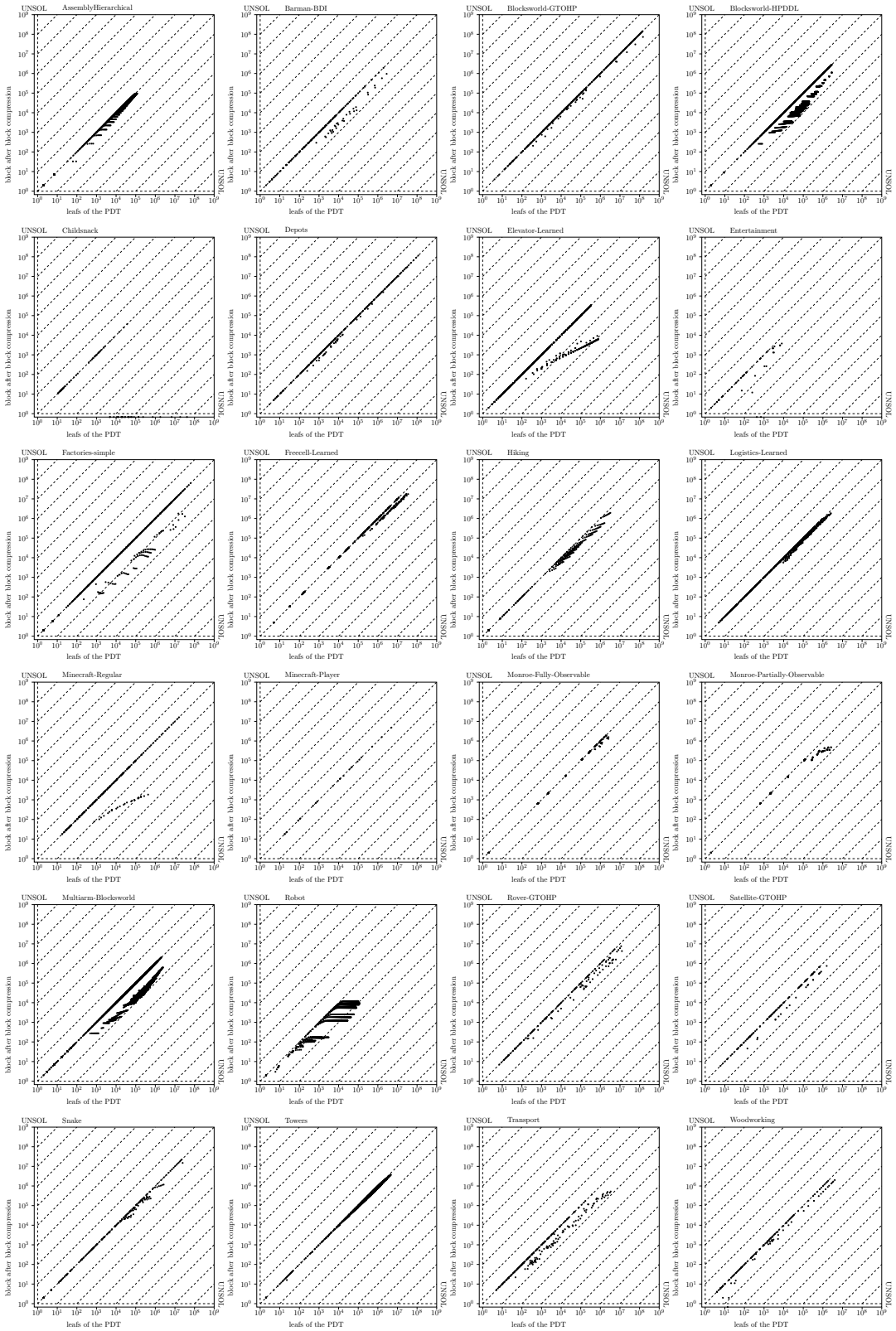

Figure 3: For every PDT created by SAT-1iB: The number of actions in the label sets of leafs before and after pruning.

		Greedy RC ADD	Greedy RC FF	**pandaPIsatt**-1iB	**pandaPIsatt**-1B	**pandaPIsatt**-1i	**pandaPIsatt**-1B	**pandaPIsatt**-2iB	**pandaPIsatt**-i	**pandaPIsatt**-B	**pandaPIsatt**-2i	**pandaPIsatt**-1	**pandaPIsatt**-2	HyperTensioN	**pandaPIsatt**-2B	Greedy RC LMC	Lilotane	**pandaPIsatt**	PANDA SAT +G	PANDA SAT	PDDL4J	SIADEX	pyHiPOP
AssemblyHierarchical	30	**30**	**30**	6	6	6	5	6	6	5	6	5	5	3	5	7	5	5	5	5	2	0	1
Barman-BDI	20	17	**20**	19	18	18	16	17	17	16	17	16	16	**20**	16	15	17	16	15	0	11	**20**	0
Blocksworld-GTOHP	30	**28**	**28**	25	23	25	25	25	23	23	24	25	25	16	25	25	23	22	16	21	16	13	1
Blocksworld-HPDDL	30	28	25	6	6	6	6	6	6	5	6	5	5	**30**	5	14	1	5	4	0	0	0	0
Childsnack	30	23	21	23	23	23	23	23	23	23	23	24	23	**30**	23	20	28	24	21	14	21	22	0
Depots	30	22	27	**28**	25	26	**28**	26	24	25	25	26	26	24	26	24	24	24	22	23	23	22	0
Elevator-Learned	147	146	146	**147**	**147**	**147**	126	**147**	**147**	128	**147**	127	128	**147**	129	146	**147**	126	73	73	2	11	2
Entertainment	12	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	8	**12**	**12**	4	**12**	**12**	**12**	5	0	1
Factories-simple	20	**9**	7	8	8	8	6	8	8	6	7	6	6	3	6	5	4	6	5	5	0	0	1
Freecell-Learned	60	18	**19**	10	10	10	10	10	9	10	10	9	10	0	10	0	12	8	0	0	0	0	0
Hiking	30	**25**	**25**	22	23	23	22	23	23	22	22	22	22	**25**	22	20	23	22	11	17	17	0	0
Logistics-Learned	80	48	49	**80**	79	64	77	52	57	74	48	65	66	22	55	75	45	53	28	26	0	0	0
Minecraft-Player	20	4	4	4	3	4	4	4	3	4	4	4	4	**5**	4	1	4	3	0	0	1	3	0
Minecraft-Regular	59	43	43	40	37	34	40	39	32	38	34	33	33	**58**	40	41	37	32	26	22	23	35	0
Monroe-FO	20	18	18	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	12	**20**	**20**	0	2	**20**	7	0
Monroe-PO	20	8	12	**20**	**20**	**20**	**20**	15	19	**20**	14	**20**	**20**	0	17	8	**20**	**20**	0	2	1	0	0
Multiarm-Blocksworld	74	**72**	27	19	19	18	18	18	18	18	17	16	16	8	15	17	4	16	9	0	0	1	0
Robot	20	**20**	**20**	11	11	11	11	11	11	11	11	11	11	**20**	11	19	11	11	11	0	6	0	1
Rover-GTOHP	30	26	22	24	22	23	21	22	24	20	21	21	20	**30**	20	18	23	20	9	9	27	**30**	6
Satellite-GTOHP	20	**20**	17	**20**	19	18	17	19	16	19	16	18	17	**20**	18	12	15	16	10	10	**20**	0	7
Snake	20	**20**	**20**	**20**	19	**20**	**20**	19	19	19	19	**20**	19	**20**	19	**20**	**20**	19	15	14	**20**	7	2
Towers	20	13	13	8	8	8	7	8	8	7	8	7	7	**16**	7	13	9	7	6	0	14	11	2
Transport	40	32	30	**40**	**40**	**40**	35	38	**40**	35	37	35	35	**40**	36	24	34	35	31	29	33	1	18
Woodworking	30	28	28	28	26	29	29	29	27	27	**30**	28	29	7	28	19	**30**	26	17	17	6	3	4
Coverage	892	**710**	663	640	624	613	598	597	592	587	578	575	575	572	569	567	560	548	346	301	268	186	46

Table 1: Coverage Table for the IPC 2020 benchmarks.

		Greedy RC ADD	Greedy RC FF	**pandaPIsatt**-1iB	**pandaPIsatt**-1i	**pandaPIsatt**-1B	**pandaPIsatt**-2iB	**pandaPIsatt**-i	**pandaPIsatt**-B	**pandaPIsatt**-1	HyperTensioN	**pandaPIsatt**-2	**pandaPIsatt**-2B	**pandaPIsatt**-2i	**pandaPIsatt**	Lilotane	Greedy RC LMC	PDDL4J	PANDA SAT +G	PANDA SAT	SIADEX	pyHiPOP
AssemblyHierarchical	30	**1.00**	**1.00**	0.20	0.20	0.20	0.17	0.20	0.20	0.17	0.17	0.10	0.17	0.17	0.20	0.17	0.17	0.23	0.07	0.17	0.17	0.00	0.03
Barman-BDI	20	0.85	**1.00**	0.95	0.90	0.90	0.80	0.85	0.85	0.80	0.80	**1.00**	0.80	0.80	0.85	0.80	0.85	0.75	0.55	0.75	0.00	**1.00**	0.00
Blocksworld-GTOHP	30	**0.93**	**0.93**	0.83	0.83	0.77	0.83	0.83	0.77	0.77	0.83	0.53	0.83	0.83	0.80	0.73	0.77	0.83	0.53	0.53	0.70	0.43	0.03
Blocksworld-HPDDL	30	0.93	0.83	0.20	0.20	0.20	0.20	0.20	0.20	0.17	0.17	**1.00**	0.17	0.17	0.20	0.17	0.03	0.47	0.00	0.13	0.00	0.00	0.00
Childsnack	30	0.77	0.70	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.80	**1.00**	0.77	0.77	0.77	0.80	0.93	0.67	0.70	0.70	0.47	0.73	0.00
Depots	30	0.73	0.90	**0.93**	0.87	0.83	**0.93**	0.87	0.80	0.83	0.87	0.80	0.87	0.87	0.83	0.80	0.80	0.80	0.77	0.73	0.77	0.73	0.00
Elevator-Learned	147	0.99	0.99	**1.00**	**1.00**	**1.00**	0.86	**1.00**	**1.00**	0.87	0.86	**1.00**	0.87	0.88	**1.00**	0.86	**1.00**	0.99	0.01	0.50	0.50	0.07	0.01
Entertainment	12	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.67	**1.00**	**1.00**	**1.00**	**1.00**	0.33	**1.00**	0.42	**1.00**	**1.00**	0.00	0.08
Factories-simple	20	**0.45**	0.35	0.40	0.40	0.40	0.30	0.40	0.40	0.30	0.30	0.15	0.30	0.30	0.35	0.30	0.20	0.25	0.00	0.25	0.25	0.00	0.05
Freecell-Learned	60	0.30	**0.32**	0.17	0.17	0.17	0.17	0.17	0.15	0.17	0.15	0.00	0.17	0.17	0.17	0.13	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Hiking	30	**0.83**	**0.83**	0.73	0.77	0.77	0.73	0.77	0.77	0.73	0.73	**0.83**	0.73	0.73	0.73	0.73	0.77	0.67	0.57	0.37	0.57	0.00	0.00
Logistics-Learned	80	0.60	0.61	**1.00**	0.80	0.99	0.96	0.65	0.71	0.93	0.81	0.28	0.82	0.69	0.60	0.66	0.56	0.94	0.00	0.35	0.32	0.00	0.00
Minecraft-Player	20	0.20	0.20	0.20	0.20	0.15	0.20	0.20	0.15	0.20	0.20	**0.25**	0.20	0.20	0.20	0.15	0.20	0.05	0.05	0.00	0.00	0.15	0.00
Minecraft-Regular	59	0.73	0.73	0.68	0.58	0.63	0.68	0.66	0.54	0.64	0.56	**0.98**	0.56	0.68	0.58	0.54	0.63	0.69	0.39	0.44	0.37	0.59	0.00
Monroe-Fully-Observable	20	0.90	0.90	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.60	**1.00**	0.00	0.10	0.35	0.00
Monroe-Partially-Observable	20	0.40	0.60	**1.00**	**1.00**	**1.00**	**1.00**	0.75	0.95	**1.00**	**1.00**	0.00	**1.00**	0.85	0.70	**1.00**	**1.00**	0.40	0.05	0.00	0.10	0.00	0.00
Multiarm-Blocksworld	74	**0.97**	0.36	0.26	0.24	0.26	0.24	0.24	0.24	0.24	0.22	0.11	0.22	0.20	0.23	0.22	0.05	0.23	0.00	0.12	0.00	0.01	0.00
Robot	20	**1.00**	**1.00**	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	**1.00**	0.55	0.55	0.55	0.55	0.55	**0.95**	0.30	0.55	0.00	0.00	0.05
Rover-GTOHP	30	0.87	0.73	0.80	0.77	0.73	0.70	0.73	0.80	0.67	0.70	**1.00**	0.67	0.67	0.70	0.67	0.77	0.60	0.90	0.30	0.30	**1.00**	0.20
Satellite-GTOHP	20	**1.00**	0.85	**1.00**	0.90	0.95	0.85	0.95	0.80	0.95	0.90	**1.00**	0.85	0.90	0.80	0.80	0.75	0.60	**1.00**	0.50	0.50	0.00	0.35
Snake	20	**1.00**	**1.00**	**1.00**	**1.00**	0.95	**1.00**	0.95	0.95	0.95	**1.00**	**1.00**	0.95	0.95	0.95	0.95	**1.00**	**1.00**	**1.00**	0.75	0.70	0.35	0.10
Towers	20	0.65	0.65	0.40	0.40	0.40	0.35	0.40	0.40	0.35	0.35	**0.80**	0.35	0.35	0.40	0.35	0.45	0.65	0.70	0.30	0.00	0.55	0.10
Transport	40	0.80	0.75	**1.00**	**1.00**	**1.00**	0.88	0.95	**1.00**	0.88	0.88	**1.00**	0.88	0.90	0.93	0.88	0.85	0.60	0.82	0.77	0.73	0.03	0.45
Woodworking	30	0.93	0.93	0.93	0.97	0.87	0.97	0.97	0.90	0.90	0.93	0.23	0.97	0.93	**1.00**	0.87	**1.00**	0.63	0.20	0.57	0.57	0.10	0.13
	892	**18.8450**	18.1827	17.0014	16.5028	16.4714	16.1325	16.0543	15.8981	15.8247	15.7770	15.7328	15.6796	15.5457	15.5310	15.1199	14.8603	14.6053	10.0284	9.7839	8.1028	6.1066	1.5969

Table 2: Normalised Coverage Table for the IPC 2020 benchmarks.

		HyperTensioN	Greedy RC ADD	Greedy RC FF	**pandaPIsatt-**iiB	**pandaPIsatt-**1i	**pandaPIsatt-**iB	**pandaPIsatt-**1B	Lilotane	**pandaPIsatt-**i	**pandaPIsatt-**1	**pandaPIsatt-**2	**pandaPIsatt-**B	**pandaPIsatt-**2iB	**pandaPIsatt**	**pandaPIsatt-**2i	**pandaPIsatt-**2B	Greedy RC LMC	PDDL4J	PANDA SAT +G	SIADEX	PANDA SAT	pyHiPOP
AssemblyHierarchical	30	0.08	**0.93**	0.91	0.15	0.14	0.15	0.14	0.13	0.15	0.14	0.14	0.14	0.15	0.14	0.15	0.14	0.19	0.06	0.11	0.00	0.11	0.02
Barman-BDI	20	**1.00**	0.73	0.86	0.79	0.74	0.77	0.70	0.75	0.73	0.67	0.67	0.68	0.72	0.67	0.71	0.68	0.54	0.49	0.37	**0.92**	0.00	0.00
Blocksworld-GTOHP	30	0.43	**0.88**	**0.88**	0.76	0.73	0.63	0.79	0.71	0.60	0.78	0.78	0.67	0.71	0.63	0.69	0.73	0.74	0.43	0.24	0.34	0.32	0.01
Blocksworld-HPDDL	30	**0.89**	0.72	0.65	0.12	0.11	0.12	0.10	0.02	0.11	0.10	0.10	0.10	0.11	0.10	0.10	0.10	0.26	0.00	0.05	0.00	0.00	0.00
Childsnack	30	**1.00**	0.68	0.65	0.70	0.71	0.70	0.72	0.87	0.71	0.71	0.70	0.72	0.72	0.71	0.71	0.70	0.41	0.47	0.35	0.50	0.19	0.00
Depots	30	0.76	0.73	0.85	0.85	0.80	0.78	**0.86**	0.74	0.74	0.81	0.81	0.79	0.77	0.76	0.75	0.77	0.75	0.60	0.40	0.70	0.45	0.00
Elevator-Learned	147	**1.00**	0.63	0.63	0.91	0.85	0.88	0.49	0.76	0.80	0.47	0.47	0.49	0.81	0.47	0.78	0.49	0.56	0.01	0.24	0.07	0.24	0.01
Entertainment	12	0.54	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	0.16	0.94	**0.95**	**0.95**	**0.95**	0.91	**0.95**	0.88	0.94	**0.95**	0.27	0.65	0.00	0.59	0.07
Factories-simple	20	0.14	**0.32**	0.27	0.29	0.28	0.29	0.22	0.18	0.27	0.21	0.21	0.22	0.29	0.21	0.27	0.22	0.21	0.00	0.14	0.00	0.14	0.01
Freecell-Learned	60	0.00	0.06	0.08	**0.10**	0.08	0.09	0.09	0.08	0.07	0.08	0.08	0.07	0.07	0.05	0.06	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Hiking	30	**0.83**	0.72	0.72	0.65	0.65	0.63	0.63	0.69	0.62	0.62	0.62	0.62	0.63	0.60	0.63	0.61	0.32	0.39	0.13	0.00	0.21	0.00
Logistics-Learned	80	0.26	0.45	0.48	**0.69**	0.50	0.62	0.52	0.34	0.43	0.41	0.41	0.48	0.30	0.37	0.26	0.31	0.51	0.00	0.13	0.00	0.15	0.00
Minecraft-Player	20	**0.25**	0.07	0.07	0.09	0.09	0.07	0.09	0.12	0.07	0.09	0.09	0.09	0.09	0.07	0.08	0.09	0.02	0.03	0.00	0.13	0.00	0.00
Minecraft-Regular	59	**0.88**	0.58	0.58	0.49	0.43	0.45	0.50	0.43	0.40	0.43	0.43	0.47	0.38	0.40	0.37	0.38	0.45	0.32	0.20	0.33	0.14	0.00
Monroe-Fully-Observable	20	**0.97**	0.49	0.50	0.72	0.66	0.62	0.74	0.89	0.60	0.72	0.72	0.65	0.44	0.64	0.32	0.45	0.24	0.57	0.00	0.25	0.02	0.00
Monroe-Partially-Observable	20	0.00	0.22	0.25	0.58	0.54	0.57	0.57	**0.84**	0.51	0.57	0.58	0.58	0.31	0.54	0.23	0.33	0.16	0.03	0.00	0.00	0.02	0.00
Multiarm-Blocksworld	74	0.11	**0.83**	0.33	0.14	0.13	0.14	0.13	0.04	0.13	0.12	0.12	0.13	0.13	0.12	0.12	0.12	0.19	0.00	0.05	0.01	0.00	0.00
Robot	20	**0.96**	0.93	0.94	0.54	0.54	0.54	0.51	0.52	0.54	0.50	0.50	0.51	0.54	0.50	0.54	0.51	0.78	0.27	0.39	0.00	0.00	0.05
Rover-GTOHP	30	**0.92**	0.60	0.52	0.61	0.59	0.57	0.55	0.57	0.59	0.54	0.53	0.53	0.51	0.52	0.50	0.50	0.38	0.62	0.20	0.77	0.20	0.14
Satellite-GTOHP	20	**1.00**	0.71	0.59	0.75	0.66	0.69	0.69	0.62	0.60	0.67	0.64	0.72	0.63	0.62	0.58	0.62	0.45	0.73	0.28	0.00	0.30	0.19
Snake	20	**1.00**	0.90	0.89	0.84	0.84	0.76	0.83	0.96	0.77	0.84	0.83	0.73	0.85	0.77	0.84	0.85	0.71	0.71	0.36	0.29	0.30	0.03
Towers	20	**0.77**	0.50	0.50	0.33	0.33	0.30	0.30	0.39	0.30	0.31	0.30	0.28	0.34	0.28	0.33	0.31	0.46	0.58	0.17	0.47	0.00	0.09
Transport	40	**1.00**	0.70	0.61	0.90	0.89	0.89	0.79	0.77	0.88	0.79	0.78	0.78	0.85	0.77	0.85	0.81	0.49	0.70	0.50	0.03	0.49	0.23
Woodworking	30	0.22	0.66	0.66	0.76	0.77	0.72	0.76	**0.99**	0.73	0.75	0.76	0.72	0.76	0.72	0.76	0.74	0.55	0.17	0.39	0.10	0.39	0.09
	892	**15.0193**	15.0022	14.3994	13.6912	12.9962	12.9330	12.6627	12.5444	12.2909	12.2570	12.2021	12.1235	11.9966	11.5983	11.5241	11.4591	10.2949	7.4516	5.3352	4.9293	4.2591	0.9395

Table 3: IPC Score Table for the IPC 2020 benchmarks.

		pandaPIsatt-iB	**pandaPIsatt-**1i	**pandaPIsatt-**1iB	**pandaPIsatt-**i	**pandaPIsatt-**B	**pandaPIsatt-**2iB	**pandaPIsatt-**1	**pandaPIsatt-**2i	**pandaPIsatt-**2B	**pandaPIsatt-**1B	**pandaPIsatt**	**pandaPIsatt-**2	Tree-REX	PANDA SAT +G	PANDA SAT
Barman	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Blocksworld	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	18	19
Childsnack	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	13
Depots	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Entertainment	12	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Gripper	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Hiking	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	19	12	16
Rover	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	9	9
Satellite	20	**20**	**20**	**20**	19	19	19	18	18	18	17	16	16	15	10	10
Transport	30	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	202	**202**	**202**	**202**	201	201	201	200	200	200	199	198	198	196	171	169

Table 4: Coverage Table for the bechmarks by Schreiber et al. (2019).

		pandaPIsatt-iB	**pandaPIsatt-**1i	**pandaPIsatt-**1iB	**pandaPIsatt-**i	**pandaPIsatt-**B	**pandaPIsatt-**2iB	**pandaPIsatt-**1	**pandaPIsatt-**2i	**pandaPIsatt-**2B	**pandaPIsatt-**1B	**pandaPIsatt**	**pandaPIsatt-**2	Tree-REX	PANDA SAT +G	PANDA SAT
Barman	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Blocksworld	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.90	0.95
Childsnack	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.65
Depots	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Entertainment	12	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Gripper	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Hiking	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.95	0.60	0.80
Rover	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.45	0.45
Satellite	20	**1.00**	**1.00**	**1.00**	0.95	0.95	0.95	0.90	0.90	0.90	0.85	0.80	0.80	0.75	0.50	0.50
Transport	30	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	202	**10**	**10**	**10**	9.95	9.95	9.95	9.9	9.9	9.9	9.85	9.8	9.8	9.7	8.45	8.35

Table 5: Normalised Coverage Table for the bechmarks by Schreiber et al. (2019).

		pandaPIsatt-1iB	**pandaPIsatt-1B**	**pandaPIsatt-1i**	**pandaPIsatt-1**	**pandaPIsatt-2**	**pandaPIsatt-B**	**pandaPIsatt-iB**	**pandaPIsatt-2iB**	**pandaPIsatt-2B**	**pandaPIsatt-2i**	**pandaPIsatt-i**	**pandaPIsatt**	Tree-REX	PANDA SAT	PANDA SAT +G
Barman	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.98	0.99	0.97	0.97	0.98	0.75	0.53	0.46
Blocksworld	20	0.99	**1.00**	0.97	0.99	0.99	0.90	0.87	0.95	0.97	0.93	0.83	0.87	0.75	0.45	0.36
Childsnack	20	0.97	**0.99**	0.98	0.98	0.98	**0.99**	0.97	0.98	0.98	0.98	0.98	0.98	0.63	0.27	0.50
Depots	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.99	0.99	0.98	0.97	0.99	0.76	0.61	0.56
Entertainment	12	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	0.73	0.70	0.74
Gripper	20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	0.74	0.71
Hiking	20	**0.92**	0.89	0.90	0.89	0.89	0.88	0.89	0.89	0.87	0.88	0.88	0.87	0.62	0.30	0.19
Rover	20	**0.84**	0.81	0.83	0.79	0.78	0.79	0.82	0.74	0.73	0.73	0.81	0.76	0.72	0.29	0.29
Satellite	20	**0.74**	0.69	0.69	0.66	0.64	0.71	0.69	0.63	0.61	0.60	0.61	0.61	0.56	0.30	0.28
Transport	30	**1.00**	0.98	**1.00**	0.98	0.98	0.98	0.99	0.99	0.98	0.99	0.99	0.97	0.93	0.66	0.66
	202	**9.41349**	9.31507	9.30195	9.23508	9.20049	9.2001	9.17773	9.09849	9.0789	9.01056	8.97833	8.97407	7.45078	4.84255	4.74597

Table 6: IPC Score Table for the bechmarks by Schreiber et al. (2019).

	PDTs	% fully pruned (1iB)	% leaf-primitive pruning on remaining (1iB)	PDTs	% fully pruned (2iB)	% leaf-primitive pruning on remaining (2iB)	both PDTs	% fully pruned (1iB)	% further fully pruned (2iB)	% leaf-primitive pruning on remaining (1iB vs 2iB)
AssemblyHierarchical	1309	73.34	78.33	1309	73.34	78.33	1309	73.34	0.00	0.00
Barman-BDI	191	83.77	28.07	172	84.30	27.42	172	84.30	0.00	0.03
Blocksworld-GTOHP	425	93.41	65.41	289	92.04	67.63	289	92.04	0.00	0.00
Blocksworld-HPDDL	3536	53.45	23.96	1392	77.01	33.11	1392	60.70	16.31	12.07
Childsnack	78	66.67	0.00	75	69.33	0.00	75	69.33	0.00	0.00
Depots	270	88.52	66.69	192	87.50	64.61	192	86.46	1.04	1.40
Elevator-Learned	1174	85.78	5.93	1174	85.78	5.93	1174	85.78	0.00	0.00
Entertainment	51	70.59	36.73	51	70.59	36.73	51	70.59	0.00	0.00
Factories-simple	566	87.10	8.39	435	88.05	7.67	434	85.71	2.53	0.60
Freecell-Learned	649	81.97	59.04	563	95.56	64.40	563	92.54	3.02	4.04
Hiking	253	41.11	60.82	251	41.43	60.83	251	41.43	0.00	0.00
Logistics-Learned	1036	77.12	74.20	956	88.60	75.64	956	82.11	6.49	4.89
Minecraft-Player	26	84.62	96.24	26	84.62	96.24	26	84.62	0.00	0.00
Minecraft-Regular	326	88.04	3.77	280	88.21	4.33	280	88.21	0.00	0.00
Monroe-Fully-Observable	158	70.89	89.54	158	70.89	90.35	158	70.89	0.00	0.82
Monroe-Partially-Observable	165	24.24	62.62	156	25.64	68.05	156	25.64	0.00	2.01
Multiarm-Blocksworld	5987	43.64	17.86	3661	84.21	20.64	3661	69.41	14.80	4.01
Robot	1252	1.60	26.42	1199	1.67	34.07	1199	1.67	0.00	6.77
Rover-GTOHP	165	67.88	52.30	153	85.62	54.61	153	71.90	13.73	10.49
Satellite-GTOHP	119	83.19	41.23	110	85.45	39.74	110	85.45	0.00	0.00
Snake	231	73.59	77.53	230	83.04	87.11	230	73.91	9.13	18.19
Towers	1740	15.29	85.69	1511	17.60	89.43	1472	18.07	0.00	3.07
Transport	239	62.76	33.34	231	81.82	30.38	231	64.94	16.88	0.00
Woodworking	142	61.97	67.23	142	61.97	68.56	142	61.97	0.00	1.33
	20088	53.01	37.47	14716	68.37	53.44	14676	62.14	6.42	4.30

Table 7: Per-domain analysis of the strength of unary and binary invariant pruning on the IPC 2020 benchmark domains.