Improving Greedy Best-First Search by Removing Unintended Search Bias

Submision 1537

Evaluation under Blind Search

We also compared the blind search performance with and without our 2 diversification schemes in order to assess their pure effect not affected by any particular heuristics. We compared the performance of (h) the standard GBFS $[h]$ and its enhancements: (hd) bucket diversification $[h, \langle d \rangle]$, (hb) IP diversification $[h, r_{\text{BIP}}]$. Due to the characteristics of Blind heuristics, the only meaningful diversification is intra-plateau diversification: It always returns a constant value 1.

The results show that both (hd) and (hb) improves the performance of blind search while not strictly dominating each other: (hb) shows better performance than (hd) on Tidybot domain. The improvements are domain-dependent and we did not observe difference in domains not listed in the table.

Finally, we also compared the simple random selection (*ro*) with a selection based on fixed random values (hb). The results indicate that the baseline performance of IP-diversification and *ro* default tiebreaking are different in tidybot and pegsol.

	h	hb	hd	*ro*
ipc2014 sum	14	15	**22**	15
hiking	2	2	**7**	2
tetris	0	1	**3**	1
ipc2011 sum	30	48	**50.8**	35
pegsol	17	18.5	**19**	17
scanalyzer	4	4	**6**	4
sokoban	3	3	**3.8**	3
tidybot	2	**17.5**	14	6
visitall	0	0	**3**	0

Table S1: Blind search results of 3 minutes runs (average of 4 runs). (hd) and (hb) are not dominating each other and (hb) and (*ro*) are different.

	h^{CG}									h^{FF}								
				fifo				*lifo*	*ro*				*fifo*				*lifo*	*ro*
domain	h	hd	ht(g,h)	ht(g)	ht(h)	hb	hB	h	h	h	hd	ht(g,h)	ht(g)	hb	hB	ht(h)	h	h
ipc2011	151.0	157.3	160.8	160.8	156.0	158.0	**175.0**	150.5	155.3	158.3	169.0	171.5	173.0	170.5	**198.3**	164.5	159.8	170.0
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	8.3	10.5	9.0	8.3	**16.8**	8.0	0.8	8.5
elevators	9.0	8.0	8.8	8.8	9.0	9.8	**13.3**	8.0	8.3	18.5	14.0	16.0	17.0	18.0	**19.0**	15.3	10.0	16.8
floortile	0.0	0.0	**2.3**	2.0	1.8	0.0	0.5	0.0	0.0	5.8	6.3	7.3	**7.8**	4.3	5.3	7.3	5.0	4.8
nomystery	7.0	6.0	**15.8**	8.0	8.0	6.3	5.5	7.0	7.0	9.0	7.0	**16.5**	9.0	6.8	7.5	9.3	6.0	7.5
openstacks	10.0	**14.8**	10.0	10.8	10.0	12.0	13.5	13.8	12.0	11.0	18.3	11.0	13.0	19.5	17.3	13.0	19.0	**19.8**
parcprinter	**20.0**	**20.0**	19.5	16.8	18.3	19.8	13.0	**20.0**	19.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
parking	18.0	18.0	11.5	15.5	14.8	**19.8**	**19.8**	15.0	**19.8**	10.5	**20.0**	9.8	10.3	17.0	13.3	9.3	**20.0**	16.5
pegsol	20.0	20.0	20.0	20.0	20.0	20.0	19.8	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
scanalyzer	20.0	20.0	20.0	20.0	19.8	20.0	20.0	20.0	20.0	15.5	15.3	17.8	**19.0**	16.8	18.8	18.3	17.0	16.3
sokoban	16.0	16.0	16.8	16.3	**17.0**	15.8	16.0	15.0	16.0	**19.0**	**19.0**	17.3	17.3	18.5	18.3	17.8	**19.0**	18.5
tidybot	16.0	18.0	**18.3**	15.0	**18.3**	18.0	16.8	14.0	17.3	16.0	16.0	16.0	16.0	14.8	**16.3**	14.8	16.0	15.3
transport	10.0	11.5	9.0	10.3	8.5	11.0	12.3	**13.0**	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	3.0	3.0	6.3	8.8	5.5	3.8	**10.0**	3.8	4.0	3.0	3.0	6.0	7.8	5.3	**11.3**	6.8	5.0	4.5
woodworking	2.0	2.0	2.8	8.8	5.3	2.0	**14.8**	1.0	1.5	2.0	2.0	3.5	7.0	1.5	**14.8**	5.0	2.0	1.8
ipc2014	76.5	85.0	85.5	72.5	73.8	77.0	**88.3**	69.8	80.5	71.5	95.3	78.8	70.3	91.0	98.3	67.5	**98.5**	90.0
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.3	0.0	**7.8**	0.0	0.0	0.0
cavediving	7.0	7.0	7.0	7.0	**7.3**	**7.3**	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	**7.3**	7.0	7.0
childsnack	1.0	**6.0**	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	**4.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
citycar	0.0	0.0	**8.3**	3.0	0.0	0.3	1.3	0.0	3.8	0.0	0.0	**7.0**	3.8	0.0	2.8	1.8	0.0	0.0
floortile	0.0	0.0	**2.0**	1.8	1.8	0.0	0.3	0.0	0.0	2.0	2.0	2.0	2.0	2.0	**2.3**	2.0	2.0	2.0
ged	0.0	0.0	**9.5**	0.3	6.8	0.0	4.3	0.0	0.0	19.0	19.0	13.8	11.5	18.8	12.5	15.0	19.0	**20.0**
hiking	18.0	16.8	**19.5**	18.0	18.3	15.8	18.3	16.0	15.8	**20.0**	**20.0**	19.8	19.3	18.0	**20.0**	19.5	17.0	17.8
maintenance	16.0	16.0	**16.3**	15.3	15.8	14.0	15.8	16.0	14.8	11.0	8.0	10.8	10.5	6.8	10.8	8.3	**12.0**	8.0
openstacks	0.0	**3.5**	0.0	0.0	0.0	0.0	2.3	2.5	0.0	0.0	12.3	0.0	0.8	**14.8**	11.3	0.3	14.3	14.5
parking	6.8	9.8	0.8	3.3	2.0	**11.3**	8.3	2.0	10.0	3.3	7.3	1.3	1.3	5.8	1.5	2.0	**12.3**	3.5
tetris	17.8	18.0	14.0	14.3	12.5	**20.0**	18.0	14.0	19.5	1.3	6.8	3.3	3.5	**9.3**	8.3	1.3	4.0	8.0
thoughtful	5.0	5.0	5.0	5.0	5.0	4.5	5.0	5.0	5.5	8.0	9.0	**13.0**	10.5	8.8	11.0	10.3	11.0	9.3
transport	5.0	3.0	3.3	4.8	4.5	4.0	**6.0**	5.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	0.0	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.3**	0.0	0.0	0.0

Table S2: Eager GBFS results (extended). Average of 4 runs, 5 minutes time limit with 4GB memory limit.

	h^{CG}									h^{FF}								
				fifo				*lifo*	*ro*				*fifo*				*lifo*	*ro*
domain	h	hd	ht(g,h)	ht(g)	ht(h)	hb	hB	h	h	h	hd	ht(g,h)	ht(g)	ht(h)	hb	hB	h	h
ipc2011	151	156	153	151	143	150	**167**	149	151	156	168	163	164	157	162	**187**	159	158
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	8.0	10.0	9.0	6.0	7.0	**15.0**	0.0	8.0
elevators	9.0	8.0	8.0	8.0	8.0	9.0	**13.0**	8.0	7.0	**18.0**	14.0	15.0	16.0	15.0	17.0	**18.0**	10.0	14.0
floortile	0.0	0.0	**2.0**	**2.0**	1.0	0.0	0.0	0.0	0.0	5.0	6.0	6.0	6.0	**7.0**	4.0	4.0	5.0	4.0
nomystery	7.0	6.0	**15.0**	7.0	7.0	6.0	5.0	7.0	7.0	9.0	7.0	**16.0**	9.0	9.0	6.0	7.0	6.0	6.0
openstacks	10.0	**14.0**	10.0	10.0	10.0	12.0	13.0	13.0	12.0	11.0	18.0	11.0	13.0	13.0	**19.0**	17.0	**19.0**	**19.0**
parcprinter	**20.0**	**20.0**	19.0	15.0	15.0	19.0	12.0	**20.0**	19.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
parking	18.0	18.0	10.0	14.0	13.0	**19.0**	**19.0**	15.0	**19.0**	10.0	**20.0**	8.0	8.0	8.0	16.0	12.0	**20.0**	14.0
pegsol	20.0	20.0	20.0	20.0	20.0	20.0	19.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
scanalyzer	20.0	20.0	20.0	20.0	19.0	20.0	20.0	20.0	20.0	15.0	15.0	17.0	**18.0**	**18.0**	16.0	**18.0**	17.0	16.0
sokoban	16.0	16.0	16.0	16.0	16.0	15.0	16.0	15.0	16.0	**19.0**	**19.0**	17.0	17.0	17.0	18.0	17.0	19.0	18.0
tidybot	16.0	**18.0**	17.0	13.0	17.0	17.0	16.0	14.0	17.0	**16.0**	**16.0**	15.0	15.0	14.0	14.0	14.0	**16.0**	14.0
transport	10.0	11.0	8.0	10.0	8.0	9.0	11.0	**13.0**	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	3.0	3.0	6.0	8.0	5.0	3.0	**10.0**	3.0	4.0	3.0	3.0	5.0	7.0	6.0	4.0	**11.0**	5.0	4.0
woodworking	2.0	2.0	2.0	8.0	4.0	1.0	**13.0**	1.0	1.0	2.0	2.0	3.0	6.0	4.0	1.0	**14.0**	2.0	1.0
ipc2014	75	**83**	78	66	62	72	80	69	71	71	93	70	63	59	82	88	**98**	78
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**7.0**	0.0	0.0
cavediving	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
childsnack	1.0	**6.0**	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	**4.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
citycar	0.0	0.0	6.0	2.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	**6.0**	3.0	1.0	0.0	2.0	0.0	0.0
floortile	0.0	0.0	**2.0**	1.0	1.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ged	0.0	0.0	**8.0**	0.0	5.0	0.0	3.0	0.0	0.0	19.0	19.0	13.0	11.0	14.0	18.0	12.0	19.0	**20.0**
hiking	18.0	16.0	**19.0**	17.0	17.0	15.0	17.0	16.0	14.0	**20.0**	**20.0**	19.0	18.0	19.0	17.0	**20.0**	17.0	16.0
maintenance	**16.0**	**16.0**	15.0	14.0	15.0	12.0	15.0	**16.0**	12.0	**11.0**	8.0	10.0	9.0	6.0	5.0	10.0	12.0	5.0
openstacks	0.0	**3.0**	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	12.0	0.0	0.0	0.0	**14.0**	9.0	**14.0**	13.0
parking	6.0	9.0	0.0	3.0	0.0	**10.0**	6.0	2.0	9.0	3.0	6.0	0.0	0.0	1.0	4.0	0.0	**12.0**	1.0
tetris	17.0	18.0	13.0	13.0	10.0	**20.0**	17.0	14.0	19.0	1.0	6.0	2.0	3.0	1.0	**8.0**	7.0	4.0	6.0
thoughtful	5.0	5.0	5.0	5.0	5.0	4.0	5.0	5.0	5.0	8.0	9.0	**11.0**	10.0	8.0	7.0	10.0	**11.0**	8.0
transport	5.0	3.0	3.0	4.0	2.0	4.0	**6.0**	5.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	0.0	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0

Table S3: Eager GBFS results (extended). **Minimum** of 4 runs, 5 minutes time limit with 4GB memory limit.

	h^{CG}									h^{FF}								
				fifo				*lifo*	*ro*				*fifo*				*lifo*	*ro*
domain	h	hd	ht(g,h)	ht(g)	ht(h)	hb	hB	h	h	h	hd	ht(g,h)	ht(g)	ht(h)	hb	hB	h	h
ipc2011	151	158	168	172	165	164	**182**	151	159	160	172	183	182	174	178	**210**	160	180
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	9.0	12.0	9.0	9.0	9.0	**18.0**	1.0	9.0
elevators	9.0	8.0	9.0	9.0	10.0	10.0	**14.0**	8.0	9.0	19.0	14.0	17.0	18.0	16.0	19.0	**20.0**	10.0	18.0
floortile	0.0	0.0	**3.0**	2.0	2.0	0.0	1.0	0.0	0.0	6.0	7.0	8.0	**9.0**	8.0	5.0	7.0	5.0	6.0
nomystery	7.0	6.0	**16.0**	9.0	9.0	7.0	6.0	7.0	7.0	9.0	7.0	**17.0**	9.0	10.0	7.0	8.0	6.0	9.0
openstacks	10.0	**15.0**	10.0	11.0	10.0	12.0	14.0	14.0	12.0	11.0	19.0	11.0	13.0	13.0	**20.0**	18.0	19.0	**20.0**
parcprinter	**20.0**	**20.0**	**20.0**	18.0	**20.0**	**20.0**	14.0	**20.0**	**20.0**	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
parking	18.0	18.0	13.0	18.0	16.0	**20.0**	**20.0**	15.0	**20.0**	11.0	**20.0**	12.0	13.0	12.0	18.0	15.0	**20.0**	19.0
pegsol	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
scanalyzer	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	16.0	16.0	19.0	**20.0**	19.0	17.0	**20.0**	17.0	17.0
sokoban	16.0	16.0	17.0	17.0	**18.0**	16.0	16.0	15.0	16.0	19.0	19.0	18.0	18.0	18.0	19.0	19.0	19.0	19.0
tidybot	16.0	18.0	**19.0**	18.0	**19.0**	**19.0**	18.0	14.0	18.0	16.0	16.0	17.0	17.0	16.0	15.0	**18.0**	16.0	16.0
transport	10.0	12.0	10.0	11.0	9.0	**13.0**	**13.0**	**13.0**	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	3.0	3.0	7.0	9.0	6.0	4.0	**10.0**	4.0	4.0	3.0	3.0	7.0	8.0	7.0	7.0	**12.0**	5.0	5.0
woodworking	2.0	2.0	4.0	10.0	6.0	3.0	**16.0**	1.0	2.0	2.0	2.0	5.0	8.0	6.0	2.0	**15.0**	2.0	2.0
ipc2014	77	86	92	81	83	82	**97**	71	89	73	97	90	79	77	100	**108**	100	99
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.0	0.0	0.0	**8.0**	0.0	0.0
cavediving	7.0	7.0	7.0	7.0	8.0	8.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	8.0	7.0	7.0	7.0	7.0
childsnack	1.0	6.0	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0	**4.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
citycar	0.0	0.0	**9.0**	5.0	0.0	1.0	2.0	0.0	5.0	0.0	0.0	**9.0**	5.0	3.0	0.0	4.0	0.0	0.0
floortile	0.0	0.0	2.0	2.0	2.0	0.0	1.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0	2.0
ged	0.0	0.0	**11.0**	1.0	8.0	0.0	5.0	0.0	0.0	19.0	19.0	15.0	13.0	16.0	19.0	13.0	19.0	**20.0**
hiking	18.0	17.0	**20.0**	**20.0**	**20.0**	16.0	19.0	16.0	17.0	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	19.0	**20.0**	17.0	19.0
maintenance	16.0	16.0	17.0	16.0	16.0	16.0	17.0	16.0	17.0	11.0	8.0	**12.0**	11.0	10.0	9.0	11.0	**12.0**	10.0
openstacks	0.0	**4.0**	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0	13.0	0.0	1.0	1.0	**16.0**	13.0	15.0	**16.0**
parking	7.0	10.0	1.0	4.0	4.0	**12.0**	11.0	2.0	**12.0**	4.0	8.0	3.0	4.0	3.0	8.0	3.0	**13.0**	5.0
tetris	18.0	18.0	16.0	16.0	14.0	**20.0**	19.0	14.0	**20.0**	2.0	7.0	5.0	4.0	2.0	**10.0**	9.0	4.0	9.0
thoughtful	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	6.0	8.0	9.0	**15.0**	11.0	12.0	10.0	13.0	11.0	11.0
transport	5.0	3.0	4.0	5.0	**6.0**	4.0	**6.0**	**6.0**	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	0.0	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4.0**	0.0	0.0

Table S4: Eager GBFS results (extended). **Maximum** of 4 runs, 5 minutes time limit with 4GB memory limit.

	h^{CG}								h^{FF}							
	fifo						*lifo*	*ro*	*fifo*						*lifo*	*ro*
domain	h	hd	ht(g,h)	ht(h)	hb	hB	h	h	h	hd	ht(g,h)	ht(h)	hb	hB	h	h
ipc2011	141.0	152.8	149.8	151.8	153.8	**179.8**	121.3	150.8	172.0	177.0	190.0	179.5	163.3	**202.3**	123.0	163.3
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	8.0	9.8	8.0	7.5	**17.8**	2.0	8.5
elevators	7.0	8.0	8.5	8.0	9.3	**14.0**	9.0	9.0	17.5	12.3	14.8	16.0	16.5	**18.0**	8.0	**18.0**
floortile	0.0	0.0	1.0	**1.5**	0.0	0.3	0.0	0.0	4.0	4.0	**7.0**	**7.0**	4.0	4.5	4.0	4.8
nomystery	5.0	5.0	**14.0**	7.0	5.0	5.3	10.0	5.5	7.0	7.0	**16.5**	8.3	5.0	6.5	5.0	5.5
openstacks	15.0	**20.0**	14.8	16.0	16.8	17.0	0.0	18.3	**20.0**	**20.0**	**20.0**	**20.0**	18.8	**20.0**	0.0	**20.0**
parcprinter	**20.0**	**20.0**	18.8	19.0	**20.0**	19.0	11.0	10.0	**20.0**	18.0	19.8	19.5	14.5	18.5	11.0	8.8
parking	11.5	11.8	4.5	9.8	16.5	16.5	3.8	**19.0**	7.5	18.8	8.8	10.3	11.8	12.3	17.0	**19.3**
pegsol	20.0	20.0	20.0	19.8	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
scanalyzer	20.0	20.0	19.0	19.3	20.0	20.0	20.0	20.0	16.0	16.0	**18.8**	18.5	16.8	**18.8**	16.0	16.8
sokoban	15.0	14.3	16.3	16.5	13.8	14.8	**17.0**	15.8	**19.0**	**19.0**	17.5	17.5	18.5	18.5	**19.0**	18.5
tidybot	15.0	**19.0**	18.0	16.3	18.3	17.3	14.0	17.5	16.0	16.0	15.8	16.0	14.3	**17.3**	14.0	15.3
transport	8.5	10.8	7.3	9.0	10.3	11.8	**12.0**	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	3.0	3.0	6.0	5.0	3.0	**10.0**	3.5	4.0	3.0	4.0	6.5	6.0	5.3	**11.5**	5.0	4.8
woodworking	1.0	1.0	1.8	4.8	1.0	**14.0**	1.0	1.3	14.0	14.0	15.0	12.5	10.5	**18.8**	2.0	3.3
ipc2014	58.8	73.3	75.3	64.5	71.8	**83.8**	44.0	74.5	84.0	90.5	**98.8**	85.3	85.8	92.8	63.8	95.8
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	**5.8**	0.0	0.0
cavediving	7.0	7.0	7.0	**7.3**	7.0	7.0	7.0	7.0	7.0	7.0	**7.3**	**7.3**	7.0	7.0	7.0	7.0
childsnack	0.0	0.0	0.0	0.0	0.0	0.0	**1.0**	0.0	0.0	**4.0**	0.3	0.0	0.0	0.0	0.0	0.0
citycar	4.0	0.0	**4.5**	0.3	0.0	2.0	0.0	1.0	0.0	0.0	**10.8**	2.0	0.0	2.5	0.0	0.0
floortile	0.0	0.0	1.3	**2.0**	0.0	0.0	0.0	0.0	2.0	2.0	**2.3**	2.0	2.0	**2.3**	2.0	2.0
ged	0.0	0.0	**11.0**	7.5	0.0	7.8	0.0	0.0	19.0	19.0	15.8	15.8	19.8	7.5	**20.0**	19.5
hiking	15.0	16.0	18.5	**18.8**	15.5	18.3	17.0	15.5	**20.0**	**20.0**	19.5	**20.0**	18.8	**20.0**	13.0	17.3
maintenance	1.0	0.0	**6.8**	0.8	0.0	0.8	0.0	0.5	5.0	0.0	**7.8**	6.0	0.5	4.3	4.0	0.5
openstacks	5.8	**20.0**	4.8	7.8	16.0	11.3	0.0	13.8	18.0	**20.0**	17.5	17.5	18.5	19.3	0.0	**20.0**
parking	2.0	3.3	0.0	0.3	5.3	5.8	0.0	**7.0**	2.0	5.3	0.3	3.0	2.5	2.3	7.8	**13.0**
tetris	16.0	18.0	14.0	12.0	19.8	17.8	9.0	**20.0**	2.0	5.3	6.3	1.3	**9.5**	7.0	3.0	8.8
thoughtful	5.0	5.0	5.0	5.0	4.5	5.3	**6.0**	5.5	9.0	8.0	11.0	10.5	7.3	**11.3**	7.0	7.8
transport	3.0	4.0	2.5	3.0	3.8	**6.0**	4.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.8**	0.0	0.0

Table S5: Lazy GBFS results. Average of 4 runs, 5 minutes time limit with 4GB memory limit.

	h^{CG}								h^{FF}							
	fifo						*lifo*	*ro*	*fifo*						*lifo*	*ro*
domain	h	hd	ht(g,h)	ht(h)	hb	hB	h	h	h	hd	ht(g,h)	ht(h)	hb	hB	h	h
ipc2011	140	151	141	142	147	**172**	120	141	171	176	179	171	153	**190**	123	154
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	8.0	9.0	7.0	7.0	**17.0**	2.0	8.0
elevators	7.0	8.0	8.0	8.0	8.0	**14.0**	9.0	8.0	**17.0**	12.0	14.0	15.0	16.0	**17.0**	8.0	**17.0**
floortile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	4.0	**7.0**	6.0	3.0	3.0	4.0	4.0
nomystery	5.0	5.0	**14.0**	7.0	5.0	5.0	10.0	5.0	7.0	7.0	**16.0**	8.0	5.0	5.0	5.0	5.0
openstacks	15.0	**20.0**	14.0	16.0	15.0	16.0	0.0	18.0	**20.0**	**20.0**	**20.0**	**20.0**	17.0	**20.0**	0.0	**20.0**
parcprinter	**20.0**	**20.0**	18.0	17.0	**20.0**	18.0	11.0	9.0	**20.0**	18.0	19.0	19.0	14.0	16.0	11.0	7.0
parking	11.0	11.0	3.0	9.0	16.0	14.0	3.0	**18.0**	7.0	**18.0**	7.0	9.0	11.0	11.0	17.0	**18.0**
pegsol	20.0	20.0	20.0	19.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
scanalyzer	20.0	20.0	18.0	19.0	20.0	20.0	20.0	20.0	16.0	16.0	17.0	**18.0**	16.0	**18.0**	16.0	16.0
sokoban	15.0	14.0	16.0	16.0	13.0	14.0	**17.0**	14.0	**19.0**	**19.0**	17.0	17.0	18.0	18.0	**19.0**	18.0
tidybot	15.0	**19.0**	17.0	15.0	18.0	17.0	14.0	16.0	**16.0**	**16.0**	15.0	15.0	13.0	**16.0**	14.0	15.0
transport	8.0	10.0	6.0	8.0	8.0	11.0	**12.0**	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	3.0	3.0	6.0	5.0	3.0	**10.0**	3.0	4.0	3.0	4.0	5.0	5.0	4.0	**11.0**	5.0	4.0
woodworking	1.0	1.0	1.0	3.0	1.0	**13.0**	1.0	1.0	14.0	14.0	13.0	12.0	9.0	**18.0**	2.0	2.0
ipc2014	56	73	68	59	67	**77**	44	70	83	**89**	**89**	77	80	84	63	88
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**5.0**	0.0	0.0
cavediving	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
childsnack	0.0	0.0	0.0	0.0	0.0	0.0	**1.0**	0.0	0.0	**4.0**	0.0	0.0	0.0	0.0	0.0	0.0
citycar	**4.0**	0.0	**4.0**	0.0	0.0	1.0	0.0	1.0	0.0	0.0	**10.0**	1.0	0.0	2.0	0.0	0.0
floortile	0.0	0.0	1.0	**2.0**	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ged	0.0	0.0	**10.0**	7.0	0.0	7.0	0.0	0.0	19.0	19.0	14.0	14.0	19.0	6.0	**20.0**	19.0
hiking	15.0	16.0	17.0	**18.0**	15.0	16.0	17.0	14.0	**20.0**	**20.0**	19.0	**20.0**	18.0	**20.0**	13.0	16.0
maintenance	1.0	0.0	**6.0**	0.0	0.0	0.0	0.0	0.0	5.0	0.0	**7.0**	4.0	0.0	3.0	4.0	0.0
openstacks	5.0	20.0	4.0	7.0	**15.0**	11.0	0.0	13.0	18.0	**20.0**	17.0	16.0	18.0	19.0	0.0	**20.0**
parking	0.0	3.0	0.0	0.0	4.0	5.0	0.0	**6.0**	2.0	5.0	0.0	2.0	2.0	1.0	7.0	**11.0**
tetris	16.0	18.0	13.0	11.0	19.0	17.0	9.0	**20.0**	1.0	4.0	3.0	1.0	**9.0**	6.0	3.0	8.0
thoughtful	5.0	5.0	5.0	5.0	4.0	5.0	**6.0**	5.0	9.0	8.0	**10.0**	**10.0**	5.0	**10.0**	7.0	5.0
transport	3.0	4.0	1.0	2.0	3.0	**6.0**	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.0**	0.0	0.0

Table S6: Lazy GBFS results (extended). **Minimum** of 4 runs, 5 minutes time limit with 4GB memory limit.

	h^{CG}								h^{FF}							
	fifo						*lifo*	*ro*	*fifo*						*lifo*	*ro*
domain	h	hd	ht(g,h)	ht(h)	hb	hB	h	h	h	hd	ht(g,h)	ht(h)	hb	hB	h	h
ipc2011	142	154	158	159	162	**188**	122	160	173	178	199	189	175	**213**	123	173
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	8.0	10.0	9.0	8.0	**19.0**	2.0	9.0
elevators	7.0	8.0	9.0	8.0	11.0	**14.0**	9.0	10.0	18.0	13.0	16.0	17.0	18.0	**19.0**	8.0	**19.0**
floortile	0.0	0.0	**2.0**	**2.0**	0.0	1.0	0.0	0.0	4.0	4.0	7.0	**8.0**	5.0	6.0	4.0	5.0
nomystery	5.0	5.0	**14.0**	7.0	5.0	6.0	10.0	6.0	7.0	7.0	**17.0**	9.0	5.0	7.0	5.0	6.0
openstacks	15.0	**20.0**	15.0	16.0	18.0	18.0	0.0	19.0	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	0.0	**20.0**
parcprinter	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	11.0	11.0	**20.0**	18.0	**20.0**	20.0	15.0	**20.0**	11.0	11.0
parking	12.0	12.0	5.0	11.0	17.0	18.0	4.0	**20.0**	8.0	19.0	11.0	12.0	14.0	13.0	17.0	**20.0**
pegsol	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
scanalyzer	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	16.0	16.0	**20.0**	19.0	17.0	**20.0**	16.0	17.0
sokoban	15.0	15.0	**17.0**	**17.0**	15.0	16.0	**17.0**	**17.0**	19.0	19.0	18.0	18.0	19.0	19.0	19.0	19.0
tidybot	15.0	19.0	**20.0**	17.0	19.0	18.0	14.0	18.0	16.0	16.0	16.0	17.0	15.0	**19.0**	14.0	16.0
transport	9.0	11.0	8.0	10.0	**13.0**	12.0	12.0	**13.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	3.0	3.0	6.0	5.0	3.0	**10.0**	4.0	4.0	3.0	4.0	7.0	7.0	6.0	**12.0**	5.0	6.0
woodworking	1.0	1.0	2.0	6.0	1.0	**15.0**	1.0	2.0	14.0	14.0	17.0	13.0	13.0	**19.0**	2.0	5.0
ipc2014	60	74	83	71	77	**91**	44	79	85	92	**111**	94	93	103	64	105
barman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	**6.0**	0.0	0.0
cavediving	7.0	7.0	7.0	8.0	7.0	7.0	7.0	7.0	7.0	7.0	8.0	8.0	7.0	7.0	7.0	7.0
childsnack	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	**4.0**	1.0	0.0	0.0	0.0	0.0	0.0
citycar	4.0	0.0	**5.0**	1.0	0.0	3.0	0.0	1.0	0.0	0.0	**13.0**	3.0	0.0	3.0	0.0	0.0
floortile	0.0	0.0	**2.0**	**2.0**	0.0	0.0	0.0	0.0	2.0	2.0	3.0	2.0	2.0	3.0	2.0	2.0
ged	0.0	0.0	**13.0**	9.0	0.0	9.0	0.0	0.0	19.0	19.0	17.0	17.0	**20.0**	9.0	**20.0**	**20.0**
hiking	15.0	16.0	**20.0**	19.0	16.0	20.0	17.0	16.0	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	13.0	19.0
maintenance	1.0	0.0	**8.0**	1.0	0.0	1.0	0.0	1.0	5.0	0.0	**9.0**	8.0	2.0	6.0	4.0	1.0
openstacks	6.0	**20.0**	5.0	8.0	17.0	12.0	0.0	15.0	18.0	**20.0**	18.0	19.0	19.0	**20.0**	0.0	**20.0**
parking	3.0	4.0	0.0	1.0	7.0	7.0	0.0	**8.0**	2.0	6.0	1.0	4.0	4.0	5.0	8.0	**15.0**
tetris	16.0	18.0	15.0	13.0	**20.0**	18.0	9.0	**20.0**	3.0	6.0	8.0	2.0	**10.0**	8.0	3.0	**10.0**
thoughtful	5.0	5.0	5.0	5.0	5.0	6.0	6.0	6.0	9.0	8.0	**12.0**	11.0	9.0	**12.0**	7.0	11.0
transport	3.0	4.0	3.0	4.0	5.0	**6.0**	4.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
visitall	0.0	0.0	0.0	0.0	0.0	**2.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4.0**	0.0	0.0

Table S7: Lazy GBFS results (extended). **Maximum** of 4 runs, 5 minutes time limit with 4GB memory limit.

	h^{CG}						h^{FF}					
diversification	none	intra	inter	intra+inter	mix	intra+mix	none	intra	inter	intra+inter	mix	intra+mix
domain	**h**	**hd**	**ht(h)**	**hdt(h)**	**ht(g,h)**	**hdt(g,h)**	**h**	**hd**	**ht(h)**	**hdt(h)**	**ht(g,h)**	**hdt(g,h)**
ipc2011	151.00	157.25	156.00	160.25	160.75	174.50	158.25	169.00	164.50	175.25	171.50	186.00
barman	0	0	0	0	0	0	8	8.25	8	8.25	10.5	10
elevators	9	8	9	9	8.75	9.5	18.5	14	15.25	14.5	16	14.25
floortile	0	0	**1.75**	**1.75**	**2.25**	**2**	5.75	6.25	**7.25**	**7.5**	**7.25**	**7**
nomystery	7	6	**8**	**7.25**	**15.75**	**15.5**	9	7	9.25	8.75	**16.5**	**16.5**
openstacks	10	*14.75*	10	*13*	10	*12.75*	11	*18.25*	13	*17.25*	11	*16*
parcprinter	20	20	18.25	17.75	19.5	18	20	20	20	20	20	20
parking	18	18	14.75	14.25	11.5	13.5	10.5	*20*	9.25	*16.75*	9.75	*16.5*
pegsol	20	20	20	20	20	20	20	20	20	20	20	20
scanalyzer	20	20	19.75	20	20	20	15.5	15.25	**18.25**	**17.75**	**17.75**	**18.25**
sokoban	16	16	**17**	**17**	**16.75**	**16.75**	19	19	17.75	17.5	17.25	17.5
tidybot	16	18	18.25	17.75	18.25	19.75	16	16	14.75	15.25	16	16.5
transport	10	*11.5*	8.5	*11.5*	9	*12.25*	0	0	0	0	0	0.25
visitall	3	3	**5.5**	**5.25**	**6.25**	**6.25**	3	3	**6.75**	**5.5**	**6**	**6.25**
woodworking	2	2	**5.25**	**5.75**	**2.75**	**8.25**	2	2	**5**	**6.25**	**3.5**	**7**
ipc2014	76.50	85.00	73.75	81.75	85.50	91.00	71.50	95.25	67.50	84.00	78.75	93.25
barman	0	0	0	0	0	0	0	0	0	0	1	1
cavediving	7	7	7.25	7.5	7	7	7	7	7.25	7	7	7.25
childsnack	1	*6*	0	*1.5*	0	*2.25*	0	*4*	0	*0.25*	0	*0.5*
citycar	0	0	0	0	**8.25**	**4.25**	0	0	**1.75**	**2.25**	**7**	**7.5**
floortile	0	0	**1.75**	**1.5**	**2**	**2**	2	2	2	2	2	2.25
ged	0	0	**6.75**	**6.25**	**9.5**	**10.25**	19	19	15	15.5	13.75	13.25
hiking	18	16.75	**18.25**	**20**	**19.5**	**20**	20	20	19.5	20	19.75	20
maintenance	16	16	15.75	16	16.25	15.5	11	8	8.25	9	10.75	10.75
openstacks	0	*3.5*	0	*0.75*	0	*0.5*	0	*12.25*	0.25	*8*	0	*6.5*
parking	6.75	*9.75*	2	*3.5*	0.75	*3.75*	3.25	*7.25*	2	*5.5*	1.25	*4.75*
tetris	17.75	18	12.5	15.5	14	15.5	1.25	*6.75*	1.25	*4*	3.25	*6*
thoughtful	5	5	5	5	5	5	8	9	**10.25**	**10.5**	**13**	**13.5**
transport	5	3	4.5	4.25	3.25	5	0	0	0	0	0	0
visitall	0	0	0	0	0	0	0	0	0	0	0	0

Table S8: Comparison of (**hdt(h)**) $alt([h, \langle d \rangle], \langle h \rangle)$, (**hdt(g,h)**) $alt([h, \langle d \rangle], \langle g, h \rangle)$ and (**hd,ht(h),ht(g,h)**). Results are highlighted arbitrarily, but **bold** highlights the results improved by inter-plateau diversification, while *underlines* highlights the results improved by intra-plateau diversification.

	h^{CG}						h^{FF}					
diversification	intra hb	inter hB	intra hw	inter hW	intra hp	inter hP	intra hb	inter hB	intra hw	inter hW	intra hp	inter hP
IPC2011	158.00	175.00	155.50	154.75	151.00	168.25	170.50	198.25	164.50	171.25	170.50	175.50
barman	0	0	0	0	0	0	8.25	16.75	9	15.75	8	10.25
elevators	9.75	13.25	9	8	8	10	18	19	17	15.25	16	16.75
floortile	0	0.5	0	2.25	0	2	4.25	5.25	5	7	6	7
nomystery	6.25	5.5	7	7.5	6	8.25	6.75	7.5	8	7.75	6	9
openstacks	12	13.5	12	10	14.75	11	19.5	17.25	18.75	11	19	13
parcprinter	19.75	13	19	15.5	19	18	20	20	20	19.5	20	20
parking	19.75	19.75	19.75	17.5	16.75	16.25	17	13.25	10	11.25	18.75	10.25
pegsol	20	19.75	20	20	20	20	20	20	20	20	20	20
scanalyzer	20	20	20	20	20	20	16.75	18.75	15.75	17.75	15.75	18.75
sokoban	15.75	16	16	15.75	16	16.5	18.5	18.25	19	19	19	19
tidybot	18	16.75	17	17	15	17.25	14.75	16.25	15	16.5	16	16.25
transport	11	12.25	10.75	9	10.5	11.25	0	0	0	0	0	0
visitall	3.75	10	3	6	3	4.75	5.25	11.25	4	6.25	4	5.5
woodworking	2	14.75	2	6.25	2	13	1.5	14.75	3	4.25	2	9.75
IPC2014	77.00	88.25	86.50	75.00	83.50	74.25	91.00	98.25	89.00	73.50	92.50	67.50
barman	0	0	0	0	0	0	0	7.75	0	8.75	0	0.25
cavediving	7.25	7	7	7	7	7	7	7	6	7	7	7
childsnack	0	0	0	0	3	0.25	0	0	0	0	2	0
citycar	0.25	1.25	3	1.5	3.25	0.75	0	2.75	0	1.75	0	1.5
floortile	0	0.25	0	2	0	2	2	2.25	2	2	2	2
ged	0	4.25	0	3	0	3	18.75	12.5	20	7.75	19	12.5
hiking	15.75	18.25	18	19.25	18	18.25	18	20	20	19.25	20	20
maintenance	14	15.75	16	16	16	16.75	6.75	10.75	8	11	8	9.25
openstacks	0	2.25	1.75	0	3.25	0	14.75	11.25	12.25	0	12.5	1.5
parking	11.25	8.25	10.75	4	4.25	3.5	5.75	1.5	2.75	2.75	5.75	1.25
tetris	20	18	20	12.5	19.75	13.25	9.25	8.25	11	2.25	6.25	2
thoughtful	4.5	5	5	5	5	5.25	8.75	11	7	11	10	10.25
transport	4	6	5	4.75	4	4.25	0	0	0	0	0	0
visitall	0	2	0	0	0	0	0	3.25	0	0	0	0

Table S9: Supplement-only results (avg. 4 runs) of diversification using the number of successors, eager-GBFS. Let w be the number of successors of a node, and p be the number of siblings of a node (number of nodes generated by the same parents). (**hw**) is $[h, \langle w \rangle]$, (**hW**) is $alt(h, \langle w \rangle)$, (**hp**) is $[h, \langle p \rangle]$, (**hP**) is $alt(h, \langle p \rangle)$. These variants failed to compete with IP-diversification methods applied on intra- / inter-plateau diversification.

	h^{CG}						h^{FF}					
diversification	intra hb	inter hB	intra hw	inter hW	intra hp	inter hP	intra hb	inter hB	intra hw	inter hW	intra hp	inter hP
IPC2011	153.75	179.75	146.75	160.75	150.00	157.00	163.25	202.25	174.00	186.50	165.50	190.00
barman	0	0	0	0	0	0	7.5	17.75	8	9.25	8	17
elevators	9.25	14	7.75	8.75	8	8.25	16.5	18	15	15	16	16
floortile	0	0.25	0	1.5	0	2	4	4.5	4.25	6.75	4	6.5
nomystery	5	5.25	5	7.25	5	7.25	5	6.5	5	8.25	7	9.25
openstacks	16.75	17	20	15	16	16	18.75	20	20	19	20	20
parcprinter	20	19	20	19	20	16.5	14.5	18.5	18	20	18	18.5
parking	16.5	16.5	10	11.75	18.5	16.25	11.75	12.25	15.75	10.5	5.5	9.75
pegsol	20	20	20	20	20	20	20	20	20	20	20	20
scanalyzer	20	20	20	20	20	20	16.75	18.75	16	18.75	16	19
sokoban	13.75	14.75	15	16	15	16	18.5	18.5	19	18.75	19	19
tidybot	18.25	17.25	13	16.75	14	16.5	14.25	17.25	16	16.5	16	16.25
transport	10.25	11.75	12	9.75	9.5	10.25	0	0	0	0	0	0
visitall	3	10	3	4.75	3	5.5	5.25	11.5	4	5.25	4	6.75
woodworking	1	14	1	10.25	1	2.5	10.5	18.75	13	18.5	12	12
IPC2014	71.75	83.75	74.00	64.50	71.50	73.50	85.75	92.75	84.00	71.00	84.75	86.25
barman	0	0	0	0	0	0	0	5.75	0	1.25	0	11
cavediving	7	7	6	7	7	7.25	7	7	7	7	6	7.25
childsnack	0	0	0	0	0	0	0	0	0	0	0	0
citycar	0	2	4	2	3	2.5	0	2.5	0	1	0	1.25
floortile	0	0	0	2	0	2	2	2.25	2	2	2	2
ged	0	7.75	0	4.5	0	7.25	19.75	7.5	20	7.5	20	6.5
hiking	15.5	18.25	17	18.25	16	19.5	18.75	20	20	20	20	20
maintenance	0	0.75	0	0.5	0	0.75	0.5	4.25	0	3.75	0	4.75
openstacks	16	11.25	20	6.25	9.25	9	18.5	19.25	20	15.25	20	18
parking	5.25	5.75	0	1.25	7.25	4.25	2.5	2.25	5	1.5	1.75	2.75
tetris	19.75	17.75	19	12.75	20	11.5	9.5	7	4	1.5	8	2.5
thoughtful	4.5	5.25	4	5	5	5	7.25	11.25	6	10.25	7	10.25
transport	3.75	6	4	5	4	4.5	0	0	0	0	0	0
visitall	0	2	0	0	0	0	0	3.75	0	0	0	0

Table S10: Supplement-only results (avg. 4 runs) of diversification using the number of successors, lazy-GBFS. Let w be the number of successors of a node, and p be the number of siblings of a node (number of nodes generated by the same parents). (**hw**) is $[h, \langle w \rangle]$, (**hW**) is $alt(h, \langle w \rangle)$, (**hp**) is $[h, \langle p \rangle]$, (**hP**) is $alt(h, \langle p \rangle)$. These variants failed to compete with IP-diversification methods applied on intra- / inter-plateau diversification.