Better Evaluations by Analyzing Benchmark Structure

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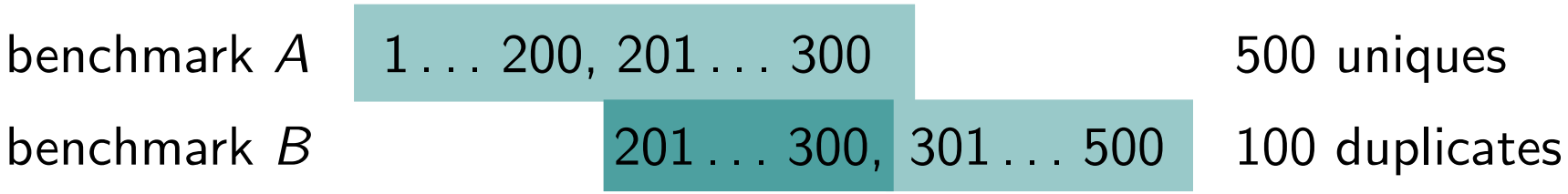
Redundancy Reduces the Significance of Evaluation Results



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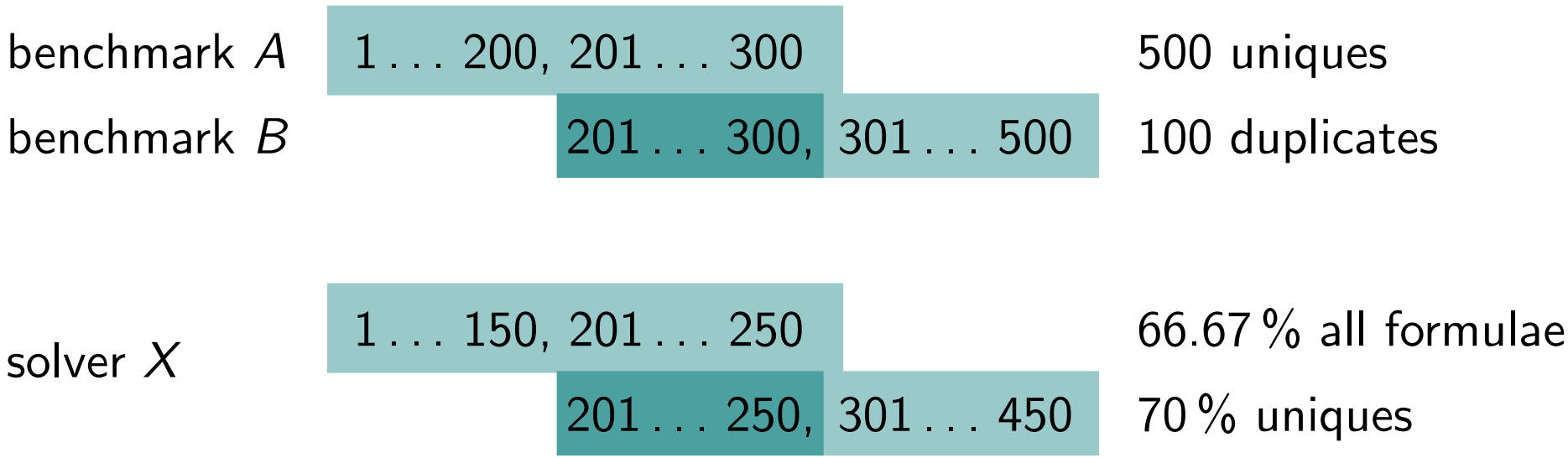

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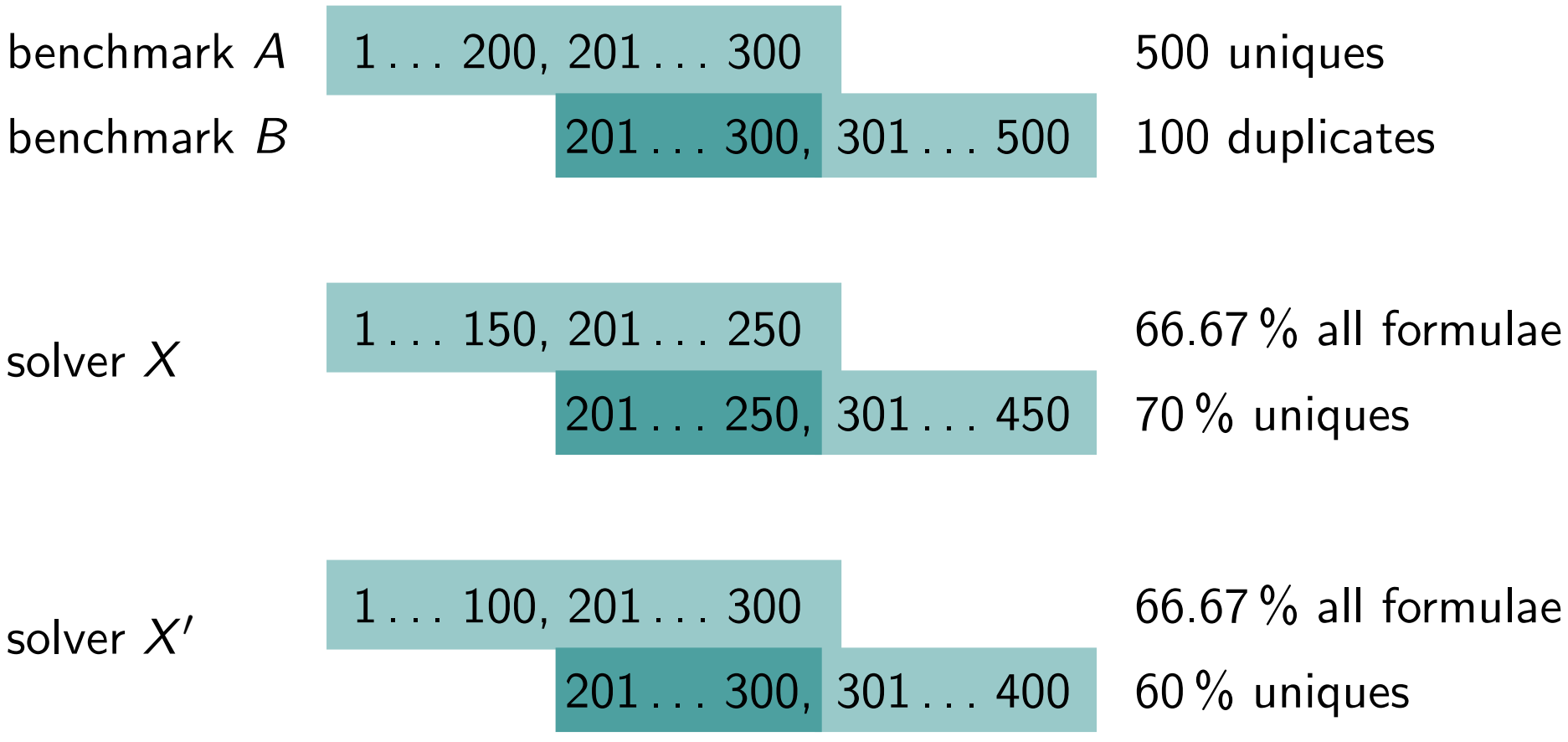

Outline

Redundancy in Benchmarks

Speeding up Solver Evaluation

Experimental Results

Conclusion and Future Work

Redundancy in Benchmarks

Feature $f : CNF \to \Sigma^*$

Feature equivalence $F \equiv_f G$ iff $f(F) = f(G)$

Redundancy-free extract Maximum subset B' of B obtained by iteratively removing G from B if $G \equiv_f F$ for any $F \in B$

Redundancy $1 - \frac{|B'|}{|B|}$

Analyzing Application Benchmark Structure

	02	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	$\sum$	N	B′
02	829														829	100 %	827
03	0	119													119	100 %	119
04	18	8	298												324	91.97 %	315
05	0	0	0	176											176	100 %	175
06	5	5	14	5	71										100	71 %	100
07	0	0	0	15	20	140									175	80 %	175
08	7	7	30	10	26	11	109								200	54.5 %	187
09	4	11	12	9	28	54	13	161							292	55.1 %	292
10	0	1	0	3	7	17	6	23	43						100	43 %	100
11	12	16	7	10	7	19	11	28	11	179					300	59.67 %	299
12	28	28	35	19	31	69	28	82	9	89	182				600	30.33 %	558
13	0	9	0	8	10	18	3	33	3	32	26	158			300	52.67 %	300
14	1	14	0	4	3	14	9	38	4	29	20	12	152		300	50.67 %	299
15	1	2	0	3	0	9	5	19	1	13	8	3	69	167	300	55.67 %	291
R	76	101	98	86	132	211	75	223	28	163	54	15	69				

Structure of SAT Competition Application Benchmarks

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14	1	14	0	4	3	14	9	38	4	29	20	12	152		*300*	50.67 %	*299*
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Redundancy in the Combination of two Benchmarks

	02	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**
03	0.21												
04	2.52	3.84											
05	0.30	0.34	2										
06	0.75	2.28	6.84	2.17									
07	0.20	0	1.80	4.56	9.09								
08	2.04	5.96	10.88	5.85	16.33	10.40							
09	0.54	2.68	5.36	2.14	10.97	16.49	11.59						
10	0.22	0.46	2.36	1.45	4.50	9.45	9	9.69					
11	1.33	4.06	3.53	2.52	3	5.26	6.2	9.80	6				
12	4.48	9.04	10.70	7.22	13.43	17.03	16.25	22.65	12.71	22.56			
13	0.18	2.15	1.76	1.89	3.50	5.68	5.40	8.78	3.75	10	18.89		
14	0.35	3.58	2.56	1.26	2	4	5.80	10.64	4.75	9.67	18.22	15.33	
15	1.06	2.63	3.21	2.73	2.25	4.42	5.80	6.59	4.50	6.33	12	8.17	23.83

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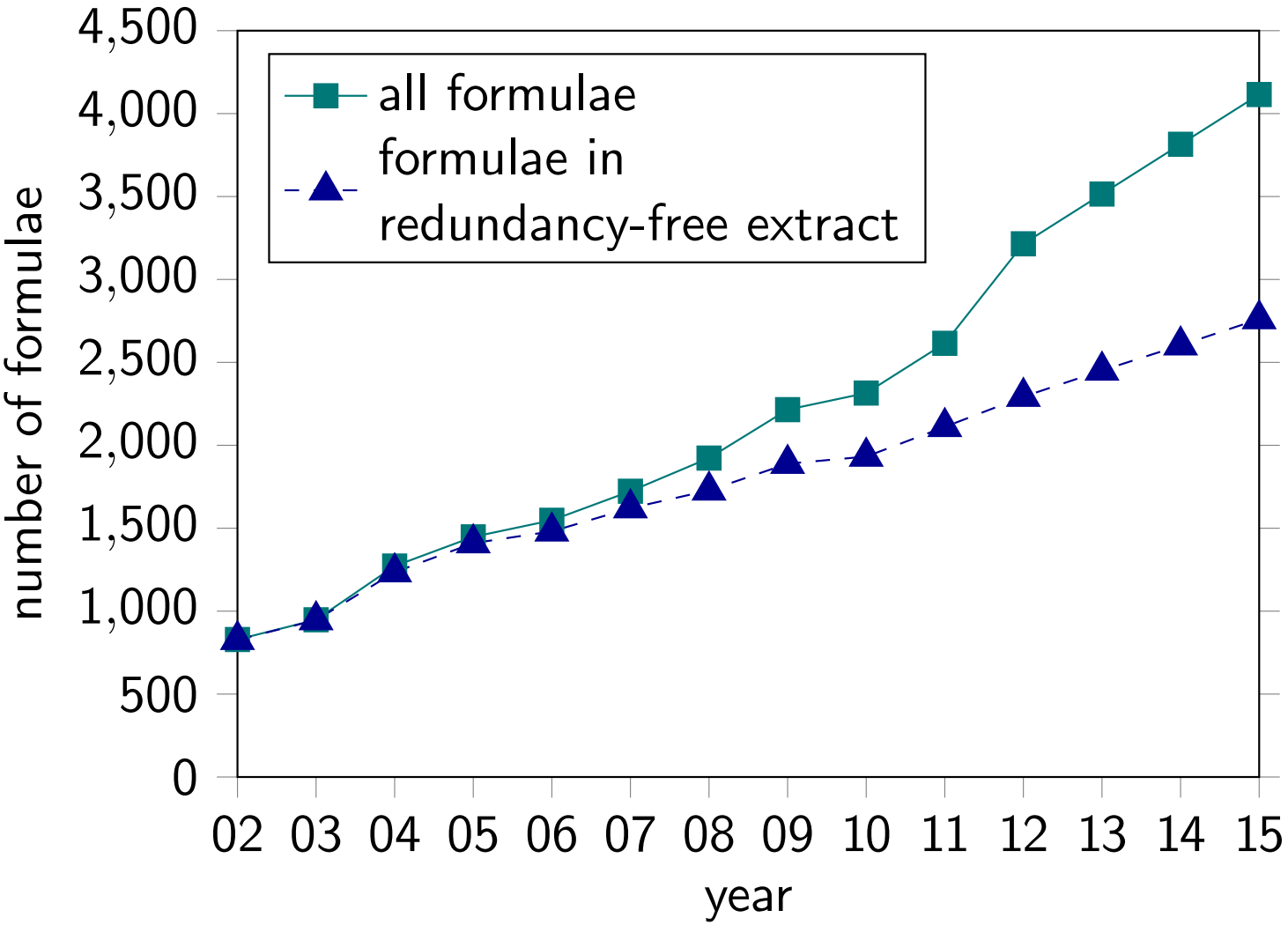
09	0.54	2.68	5.36	2.14	10.97	16.49	11.59						
10	0.22	0.46	2.36	1.45	4.50	9.45	9	9.69					
11	1.33	4.06	3.53	2.52	3	5.26	6.2	9.80	6				
12	4.48	9.04	10.70	7.22	13.43	17.03	16.25	22.65	12.71	22.56			
13	0.18	2.15	1.76	1.89	3.50	5.68	5.40	8.78	3.75	10	18.89		
14	0.35	3.58	2.56	1.26	2	4	5.80	10.64	4.75	9.67	18.22	15.33	
15	1.06	2.63	3.21	2.73	2.25	4.42	5.80	6.59	4.50	6.33	12	8.17	*23.83*

Combining Benchmarks for Intervals



Speeding up Solver Evaluation on Combined Benchmarks

1. perform evaluation on a redundancy-free extract of the combined benchmarks
2. duplicate results for feature-equivalent formulae

Experiment – Setup

Solvers

- Glucose 3.0 (2015)
- Lingeling baq (2015)
- Riss 6 (2016)

Hardware

- cluster, 2 Intel Xeon CPU E-2680 v3 with 12 cores per node, 2.50 GHz
- timeout 1 h
- memory limit 6.50 GB

Benchmarks

- *application* track of all benchmarks from 2002 to 2015
  (4115 formulae, 2761 redundancy-free formulae, redundancy 32.9 %)

Experiment – Saving in Penalized Average Run Time

solver	redundancy-free extract [h]	all formulae [h]	Δ [%]
Glucose 3.0	769.87	1106.43	30.42
Lingeling baq	692.83	1006.77	31.18
Riss 6	756.10	1105.59	31.61

Conclusion

- When benchmarks are combined, a bias in the evaluation result may be introduced.
- In the presence of redundancy in combined benchmarks, experiments should be carried out on a redundancy-free extract.
- Evaluation on a redundancy-free extract of a combination of benchmarks saves run time.

Future Work

- investigate the suitability of different features for identifying redundancy in benchmarks
- adapt the presented method to other problems, e.g., QBF, MaxSAT, PB, CSP, and AIG

Better Evaluations by Analyzing Benchmark Structure

Thank you for your attention

Experiment – Results

experiment	solver	usc	# solved	time [s]	PAR [h]
redundancy-free extract	Glucose 3.0	14	2117	453120	769.87
	Lingeling baq	88	2213	521379	692.83
	Riss 6	44	2155	540352	756.10
results mapped on full benchmark	Glucose 3.0	31	3261	899943	1103.98
	Lingeling baq	152	3393	1029790	1008.05
	Riss 6	69	3293	1024330	1106.54
evaluation on full benchmark	Glucose 3.0	31	3256	890734	1106.43
	Lingeling baq	151	3388	1007180	1006.77
	Riss 6	68	3297	1035320	1105.59