PB25
Pseudo-Boolean Competition 2025

organized by Olivier Roussel,
steering committee:
Carlos Ansótegui, Johannes Fichte, Jakob Nordström, Olivier Roussel

SAT'25
August 14th, 2025

21 years of PB competitions!

- 2005: first PB competition, organized with Vasco Manquinho
- 2006, 2007, 2009, 2010, 2011, 2012, 2015 (evaluation), 2016
- 8 years with no competition
- 2024: rebirth
- 2025: current edition
  All details are at the usual location: **https://www.cril.univ-artois.fr/PB25/**

One single solver submitted to each of those competitions since the beginning:
Sat4J

New this year:

- Globally, same organization as PB24.
- Experimental “parametric” track: test solvers on parametric instances to identify how well they scale on specific series. (work in progress)

PB25: some numbers

- 18 solvers submitters, 3 benchmarks submitters,
- 26 solvers (similar names and same authors),
- **10 new solvers**,
- 67 different solver versions among which 6 were disqualified
- more than 5 years of CPU time!
- 137 new OPT-NLC instances
- a little less than 600 new linear instances

List of solvers

New comers in bold font.

- **AI448PBSolver (Yoshiya Imai)**
- CASHWMaxSATDisj* (Shiwei Pan, Minghao Yin)
- **ExactPR* (Rui Sun, Wenbo Zhou)**
- Exact* (Jo Devriendt, Orestis Lomis)
- Hybrid-CASHWMaxSATDisjCadS+SynLSCD (Shiwei Pan, Minghao Yin)
- Hybrid-CASHWMaxSATDisj* (Yujiao Zhao, Yiyuan Wang)
- Hybrid-NuPBODeepOptS-ExactPRnols (Jieyu Wu, Shuli Hu)
- IPBHS-* (Hannes Ihalainen, Jeremias Berg, Bart Bogaerts, Matti Järvisalo)
- **LSIPExact (Peng Lin, Shaowei Cai, Yi Chu)**

List of solvers

- mixed-bag-2024 (Christoph Jabs, Jeremias Berg, Matti Järvisalo)
- NaPS (Masahiko Sakai, Hidetomo Nabeshima)
- **NuPBO-DeepOpt* (Jieyu Wu, Shuli Hu)**
- **OR-Tools CP-SAT (Laurent Perron) [LP, ILP, CSP]**
- pb-oll-rs-2024 (Christoph Jabs, Jeremias Berg, Matti Järvisalo)
- Picat, pb_picat (Neng-Fa Zhou)
- **PRINTEMPS (Yuji Koguma, Masahiro Sakai)**
- roundingsat* (Markus Anders, Benjamin Bogø, Xiamin Chen, Wietze Koops, Pinyan Lu, Jakob Nordström, Andy Oertel, Albert Oliveras, Marc Vinyals, Qingzhao Wu, Rui Zhao)
- Sat4j* (Daniel Le Berre)
- SCIP (Gioni Mexi, Shanwen Pu, Julian Manns, Marc Pfetsch, Thorsten Koch, Christopher Hojny, Alexander Hoen, Dominik Kamp, Matthias Walter, Ksenia Bestuzheva)

List of solvers (continued)

- SCIP-NaPS (Masahiko Sakai and Hidetomo Nabeshima)
- **SynLSCD* (Yujiao Zhao, Yiyuan Wang)**
- **toulbar2 (Simon de Givry) [WCSP]**
- **UWrMaxSat* (Marek Piotrów)**
- **WMaxCDCL-SCIP (Jialu Zhang, Chu-Min Li, Sami Cherif, Shuolin Li, Zhifei Zheng)**

Many thanks to all submitters!

Pseudo-Boolean Constraints

- **Linear** (LIN) pseudo-Boolean (PB) constraint = sum of integer $\times$ a literal $\{\geq, \leq, =\}$ constant
  Example: $3x_1 - 3x_2 + 2\bar{x}_3 + \bar{x}_4 + x_5 \geq 5$
- **Non-linear** (NLC) pseudo-Boolean (PB) constraint = sum of integer $\times$ a product of literals $\{\geq, \leq, =\}$ constant
  Example: $3x_1\bar{x}_2 - 3x_2x_4 + 2\bar{x}_3 + \bar{x}_4 + x_5x_6x_7 \geq 5$
- As an example, PB allows compact encodings of:
  - cardinalities: $x_1 + x_2 + x_3 \geq 2$
  - adder (C=A+B): $2c_1 + c_0 = 2a_1 + a_0 + 2b_1 + b_0$
  - knapsack:
    $max : 5x_1 + 10x_2 + 2x_3;$
    $5x_1 + 8x_2 + x_3 \leq 10$
  - integer factorization (X*Y=3): $x_0y_0 + 2x_0y_1 + 2x_1y_0 + 4x_1y_1 = 3$
- Cutting-planes proof system stronger than resolution: PHP easily solved in polynomial time

Benchmark categories (1)

Classification based on the linearity of constraints

- LIN All constraints are linear
- NLC At least one constraint is non linear (contains products of literals)

Classification based on the objective function

- DEC No objective function to optimize (decision problem). The solver must simply find a solution.
- OPT An objective function is present. The solver must find a solution with the best possible value of the objective function.

Classification based on the existence of hard/soft clauses (generalization of MaxSAT with a top cost as in WCSP)

- SOFT All constraints may be violated if needed (no hard constraint). Minimize the weight of unsatisfied constraints.
- PARTIAL At least one hard constraint.

No classification on the size of integers, but solvers that cannot deal with large integers must answer NS (no support). The limit is solver specific. Solvers expected to support at least 64 bits integers.

Rankings

- 4 base tracks: DECision, OPTimization, SOFT constraints, PARTIAL (soft+hard constraints)
- LIN (linear) and NLC (non linear) constraints
- support of large integers: ranking on all instances (including those not supported by some solvers (NS answers)) or on the subset of instances supported by all solvers
- ranking on final answers (SAT/UNSAT, OPT/UNSAT) for **complete** solvers or on the best solution found for **incomplete** solvers.
- CPU based ranking for sequential solvers or wall-clock based for parallel solvers
- generation of certified UNSAT/OPT proofs
- in the certified tracks, consider uncertified answers (UNSAT/OPT) also or only certified ones (UNSATC/OPTC)
- All in all, approximately 200 possible rankings.
- Not even counting the different scoring schemes: lexico, PAR, ...

200 rankings, seriously?

- Good news: every solver could be first in one of the rankings! (satisfiable PHP)
- Bad news: it would take a long time to present! (3 hours?)
- Fortunately, many rankings not useful (few or no solvers, few or no instances)
  - some combinations do no exist (e.g. no SOFT-NLC track)
  - **complete**/incomplete: few incomplete solvers, specific rankings on the website
  - **CPU**/wall-clock: few parallel solvers
  - lexicographic ranking: (number of instances solved, resolution time)
- Only the few most relevant rankings presented in this talk (too many already), see the web site for the rest.

New instances

- Wietze Koops: 18 instances (with a generator)
  - can a 0-1 matrix be written as a Hadamard product of k matrices?
- Masahiro Sakai: 159 instances
  - winning strategy for a board game called Doubutsu Shogi
  - conversion of QPLIB instances
  - minimal perturbation adversarial examples of BNNs (Binarized Neural Networks).
- Romain Wallon: 552 instances (but a few syntactically incorrect)
  - conversion of CSP instances in the XCSP format

Many thanks to all submitters!

Selection of instances

- Same process as last year (all details on the web page)
- A fixed number of instances selected per domain
- 15 instances per domain in the DEC-LIN track
- 10 instances randomly selected for the other domains
- If a domain doesn't contain enough instances, they are all selected.
- At most 5 % of the whole instance set selected per submitter.
- Duplicates removed (syntactical identification).

Tracks

Listed by decreasing number of registered solvers:

- **OPT-LIN: 52 solvers, 555 instances selected**
- **DEC-LIN: 43 solvers, 502 instances selected**
- OPT-NLC: 14 solvers, 57 instances selected, 3 new instances selected out of 137 (5 % limit)
  not enough instances, ranking not presented
- DEC-NLC: 13 solvers, 10 instances selected (no new instances)
  not enough instances, ranking not presented
- **PARTIAL-LIN: 10 solvers, 208 instances selected (no new instances)**
- SOFT-LIN: 10 solvers, 60 instances selected (no new instances)
  not enough instances, ranking not presented
- **DEC-LIN-CERT and OPT-LIN-CERT: 6 solvers, same selection as in DEC-LIN/OPT-LIN, solvers also ranked in DEC-LIN/OPT-LIN**

Evaluation environment

kindly provided by CRIL, University of Artois, France

- Each solver was given a time limit of 1 hour CPU time (1 hour wall-clock for the few parallel solvers, which ran on 20 cores $\Longrightarrow$ 20 hours CPU time))
- The size limit for proofs of unsatisfiability/optimality was set initially to 100 GB.
- VeriPB+CakePB was used to verify the proofs and were allowed to run for 5 hours (CPU time) later extended to 10 hours.
- Cluster of bi-CPU Intel Xeon E5-2637 v4 3.5Ghz 4 cores, 128 GB RAM *4 jobs per host, 2 cores/job, 31 GB RAM per job* This configuration was tested on a sample of benchmarks and instances and induces a slowdown of at most 10% compared to a solver running alone on the host. *It was the only configuration that allowed to complete the experiments in time.*
- For parallel solvers: nodes quad-CPU Intel Xeon Gold 6248 2.5Ghz 20 cores, 768 GB RAM, *4 jobs per host, 20 cores/job, up to 195GB/job*

Verification of results

- The usual verifications are performed:
  - the models given by the solvers are checked
  - the answers given by the different solvers on a given instance are checked for consistency
- The unsatifiability/optimality proofs in the *-CERT tracks where checked by VeriPB+CakePB. Answers OPTC and UNSC (C for Certified).
- Solvers giving a wrong answer in a category are disqualified in that category. Up to 3 submissions of bug fix were allowed.
- Not all UNSATISFIABLE and OPTIMUM FOUND answers could be checked and therefore some results should be taken with caution.

Ranking of solvers and Virtual Best Solver (VBS)

Main ranking (targeting complete solvers) based on two criteria:

1. the number of solved instances
2. ties are broken by considering the cumulated time on solved instances

A few other rankings targeting incomplete solvers are available on the web site (no perfect solution though!).

The Virtual Best Solver (VBS)

- is the virtual solver obtained by combining the best results of all submitted solvers.
- **can be obtained by running in parallel all submitted solvers**
- represents the current state of the art (SOTA)
- is a reference for the evaluation of the other solvers

Rankings on all instances
(including those unsupported by some solvers)

DEC-LIN ranking, all instances (including those unsupported)

All instances, including those not supported by some solvers, max CPU time for any solver=3605 s, incomplete solvers never answer UNSAT

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 502					
Virtual Best Solver (VBS)		468	165 SAT, 303 UNS	93%	100%
1	SCIP-NaPS	406	147 SAT, 259 UNS	81%	87%
2	*OR-Tools* **20 cores**	405	139 SAT, 266 UNS, **1 NS**	81%	87%
3	Hybrid-CASHWMaxSATDisjCadS+SynLSCD	404	140 SAT, 264 UNS	80%	86%
4	LSIPExact *S1*	402	131 SAT, 271 UNS, **1 NS**	80%	86%
5	Hybrid-CASHWMaxSATDisjComS+SynLSCD	392	132 SAT, 260 UNS	78%	84%
6	LSIPExact *S2*	389	132 SAT, 257 UNS, **1 NS**	77%	83%
7	roundingsat+pbsuma	388	126 SAT, 262 UNS	77%	83%
8	roundingsat+pbsuma-log	387	128 SAT, 1 UNS, 258 UNSC	77%	83%
9	UWrMaxSat-SCIP	384	121 SAT, 263 UNS	76%	82%
10	roundingsat-ls	380	127 SAT, 253 UNS	76%	81%

Note: parallel solvers were run on different hosts.

DEC-LIN ranking, all instances (including those unsupported)

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 502					
Virtual Best Solver (VBS)		468	165 SAT, 303 UNS	93%	100%
11	roundingsat-ls-log	380	127 SAT, 253 UNSC	76%	81%
12	SynLSCD-PS	378	128 SAT, 250 UNS	75%	81%
13	roundingsat	373	114 SAT, 259 UNS	74%	80%
14	ExactNoDomBrk	373	122 SAT, 251 UNS	74%	80%
15	roundingsat-log	371	113 SAT, 258 UNSC	74%	79%
16	SynLSCD	371	124 SAT, 247 UNS	74%	79%
17	Exact	367	119 SAT, 248 UNS	73%	78%
18	Exact_proof	365	116 SAT, 15 UNS, 234 UNSC	73%	78%
19	ExactNoDbNoLS	363	110 SAT, 253 UNS	72%	78%
20	OR-Tools	357	128 SAT, 229 UNS, **1 NS**	71%	76%
21	LSIPExact 20 cores *S1*	355	123 SAT, 232 UNS, **1 NS**	71%	76%
22	LSIPExact 20 cores *S2*	340	123 SAT, 217 UNS, **1 NS**	68%	73%
23	NaPS	323	139 SAT, 184 UNS	64%	69%
24	pb_picat	319	140 SAT, 179 UNS	64%	68%

DEC-LIN ranking, all instances (including those unsupported)

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 502					
Virtual Best Solver (VBS)		468	165 SAT, 303 UNS	93%	100%
25	CASHWMaxSATDisjCad-S	318	137 SAT, 181 UNS	63%	68%
26	UWrMaxSat	318	137 SAT, 181 UNS	63%	68%
27	AI448PBSolver	311	95 SAT, 216 UNS, **1 NS**	62%	66%
28	CASHWMaxSATDisjCom-S	308	124 SAT, 184 UNS	61%	66%
29	SCIP *25*	294	82 SAT, 212 UNS, **12 NS**	59%	63%
30	SCIP *24*	291	81 SAT, 210 UNS, **1 NS**	58%	62%
31	Sat4j Resolution	260	103 SAT, 157 UNS	52%	56%
32	Sat4j Res VeriPB	260	103 SAT, 157 UNSC	52%	56%
33	Sat4j CP VeriPB	243	68 SAT, 175 UNSC	48%	52%
34	Sat4j CP	182	54 SAT, 128 UNS	36%	39%
35	PRINTEMPS	104	104 SAT, **30 NS**	21%	22%
36	PRINTEMPS **20 cores**	99	99 SAT, **30 NS**	20%	21%

OPT-LIN ranking, all instances (including those unsupported)

All instances including those not supported by some solvers, max CPU time for any solver=3605 s, only OPT and UNSAT answers counted, incomplete solvers never answer this

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 555					
Virtual Best Solver (VBS)		439	415 OPT, 24 UNS	79%	100%
1	UWrMaxSat-SCIP	358	339 OPT, 19 UNS	65%	82%
2	Hybrid-CASHWMaxSATDisjCom+ExactPRS9	357	337 OPT, 20 UNS	64%	81%
3	Hybrid-CASHWMaxSATDisjCad+ExactPRS	356	336 OPT, 20 UNS	64%	81%
4	Hybrid-CASHWMaxSATDisjCom+ExactPRS	354	334 OPT, 20 UNS	64%	81%
5	*OR-Tools* **20 cores**	352	333 OPT, 19 UNS, **9 NS**	63%	80%
6	SCIP-NaPS	350	329 OPT, 21 UNS	63%	80%
7	ExactPR-S *2025-06-01*	347	327 OPT, 20 UNS	63%	79%
8	mixed-bag-2024	337	318 OPT, 19 UNS	61%	77%
9	roundingsat+pbsuma-opt-log	329	1 OPT, 310 OPTC, 18 UNSC	59%	75%
10	roundingsat+pbsuma-opt	326	308 OPT, 18 UNS	59%	74%

OPT-LIN ranking, all instances (including those unsupported)

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 555					
Virtual Best Solver (VBS)		439	415 OPT, 24 UNS	79%	100%
11	roundingsat-ls+pbsuma-log	323	305 OPTC, 18 UNSC	58%	74%
12	roundingsat-ls+pbsuma	317	299 OPT, 18 UNS	57%	72%
13	LSIPExact *S1*	315	296 OPT, 19 UNS, **9 NS**	57%	72%
14	LSIPExact 20 cores *S1*	311	293 OPT, 18 UNS, **9 NS**	56%	71%
15	ExactNoDomBrk	311	292 OPT, 19 UNS	56%	71%
16	ExactPR	309	290 OPT, 19 UNS	56%	70%
17	Exact	309	290 OPT, 19 UNS	56%	70%
18	SCIP *24*	308	290 OPT, 18 UNS, **9 NS**	55%	70%
19	ExactNoDbNoLS	303	284 OPT, 19 UNS	55%	69%
20	OR-Tools	301	283 OPT, 18 UNS, **9 NS**	54%	69%
21	SCIP *25*	300	282 OPT, 18 UNS, **23 NS**	54%	68%
22	IPBHS-GUROBI-SYM	293	283 OPT, 10 UNS, **46 NS**	53%	67%
23	IPBHS-GUROBI	291	281 OPT, 10 UNS, **46 NS**	52%	66%
24	WMaxCDCL-SCIP	290	276 OPT, 14 UNS, **45 NS**	52%	66%

OPT-LIN ranking, all instances (including those unsupported)

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 555					
Virtual Best Solver (VBS)		439	415 OPT, 24 UNS	79%	100%
25	Exact_proof	285	51 OPT, 214 OPTC, 20 UNSC	51%	65%
26	UWrMaxSat	280	263 OPT, 17 UNS	50%	64%
27	LSIPExact *S2*	280	262 OPT, 18 UNS, **9 NS**	50%	64%
28	CASHWMaxSATDisjCad-S	279	262 OPT, 17 UNS	50%	64%
29	CASHWMaxSATDisjCom-S	278	261 OPT, 17 UNS	50%	63%
30	IPBHS-SCIP	271	261 OPT, 10 UNS, **46 NS**	49%	62%
31	pb-oll-rs-2024	257	240 OPT, 17 UNS	46%	59%
32	LSIPExact 20 cores *S2*	256	239 OPT, 17 UNS, **9 NS**	46%	58%
33	NaPS	244	227 OPT, 17 UNS	44%	56%
34	pb_picat	224	206 OPT, 18 UNS	40%	51%
35	roundingsat-ihs	200	183 OPT, 17 UNS	36%	46%
36	roundingsat-ihs-log	200	1 OPT, 182 OPTC, 17 UNSC	36%	46%

OPT-LIN ranking, all instances (including those unsupported)

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 555					
Virtual Best Solver (VBS)		439	415 OPT, 24 UNS	79%	100%
37	Sat4j Resolution	150	133 OPT, 17 UNS	27%	34%
38	Sat4j Res VeriPB	149	6 OPT, 127 OPTC, 16 UNSC	27%	34%
39	toulbar2	145	132 OPT, 13 UNS, **9 NS**	26%	33%
40	Sat4j CP VeriPB	135	121 OPTC, 14 UNSC	24%	31%
41	Sat4j CP	117	103 OPT, 14 UNS	21%	27%
42	Hybrid-NuPBODeepOptS-ExactPRnols	0	incomplete	0%	0%
43	NuPBO-DeepOpt+	0	incomplete	0%	0%
44	NuPBO-DeepOptS+	0	incomplete	0%	0%
45	PRINTEMPS	0	incomplete, **104 NS**	0%	0%
46	PRINTEMPS **20 cores**	0	incomplete, **104 NS**	0%	0%

Rankings on the subset of instances supported by all solvers

DEC-LIN ranking, instances supported by all solvers

subset of instances supported by all solvers, max CPU time for any solver=3605 s

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 472					
	Virtual Best Solver (VBS)	439	165 SAT, 274 UNS	93%	100%
1	Hybrid-CASHWMaxSATDisjCadS+SynLSCD	390	140 SAT, 250 UNS	83%	89%
2	SCIP-NaPS	389	147 SAT, 242 UNS	82%	89%
3	LSIPExact *S1*	389	131 SAT, 258 UNS	82%	89%
4	*OR-Tools* **20 cores**	386	139 SAT, 247 UNS	82%	88%
5	Hybrid-CASHWMaxSATDisjComS+SynLSCD	379	132 SAT, 247 UNS	80%	86%
6	LSIPExact *S2*	376	132 SAT, 244 UNS	80%	86%
7	roundingsat+pbsuma	375	126 SAT, 249 UNS	79%	85%
8	roundingsat+pbsuma-log	374	128 SAT, 1 UNS, 245 UNSC	79%	85%
9	roundingsat-ls	367	127 SAT, 240 UNS	78%	84%
10	roundingsat-ls-log	367	127 SAT, 240 UNSC	78%	84%

DEC-LIN ranking, instances supported by all solvers

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 472					
Virtual Best Solver (VBS)		439	165 SAT, 274 UNS	93%	100%
11	UWrMaxSat-SCIP	367	121 SAT, 246 UNS	78%	84%
12	SynLSCD-PS	366	128 SAT, 238 UNS	78%	83%
13	ExactNoDomBrk	360	122 SAT, 238 UNS	76%	82%
14	roundingsat	359	114 SAT, 245 UNS	76%	82%
15	SynLSCD	358	124 SAT, 234 UNS	76%	82%
16	roundingsat-log	358	113 SAT, 245 UNSC	76%	82%
17	Exact	355	119 SAT, 236 UNS	75%	81%
18	Exact_proof	352	116 SAT, 15 UNS, 221 UNSC	75%	80%
19	ExactNoDbNoLS	351	110 SAT, 241 UNS	74%	80%
20	LSIPExact 20 cores *S1*	342	123 SAT, 219 UNS	72%	78%
21	OR-Tools	339	128 SAT, 211 UNS	72%	77%
22	LSIPExact 20 cores *S2*	327	123 SAT, 204 UNS	69%	74%
23	pb_picat	308	140 SAT, 168 UNS	65%	70%
24	NaPS	306	139 SAT, 167 UNS	65%	70%

DEC-LIN ranking, instances supported by all solvers

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 472					
Virtual Best Solver (VBS)		439	165 SAT, 274 UNS	93%	100%
25	CASHWMaxSATDisjCad-S	305	137 SAT, 168 UNS	65%	69%
26	UWrMaxSat	305	137 SAT, 168 UNS	65%	69%
27	AI448PBSolver	297	95 SAT, 202 UNS	63%	68%
28	CASHWMaxSATDisjCom-S	295	124 SAT, 171 UNS	63%	67%
29	SCIP *25*	286	82 SAT, 204 UNS	61%	65%
30	SCIP *24*	281	81 SAT, 200 UNS	60%	64%
31	Sat4j Resolution	249	103 SAT, 146 UNS	53%	57%
32	Sat4j Res VeriPB	249	103 SAT, 146 UNSC	53%	57%
33	Sat4j CP VeriPB	228	68 SAT, 160 UNSC	48%	52%
34	Sat4j CP	161	54 SAT, 107 UNS	34%	37%
35	PRINTEMPS	104	104 SAT	22%	24%
36	PRINTEMPS **20 cores**	99	99 SAT	21%	23%

OPT-LIN ranking, instances supported by all solvers

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 420					
Virtual Best Solver (VBS)		340	334 OPT, 6 UNS	81%	100%
1	Hybrid-CASHWMaxSATDisjCom+ExactPRS9	289	286 OPT, 3 UNS	69%	85%
2	Hybrid-CASHWMaxSATDisjCad+ExactPRS	287	284 OPT, 3 UNS	68%	84%
3	Hybrid-CASHWMaxSATDisjCom+ExactPRS	286	283 OPT, 3 UNS	68%	84%
4	UWrMaxSat-SCIP	285	283 OPT, 2 UNS	68%	84%
5	ExactPR-S *2025-06-01*	280	277 OPT, 3 UNS	67%	82%
6	SCIP-NaPS	280	277 OPT, 3 UNS	67%	82%
7	*OR-Tools* **20 cores**	277	274 OPT, 3 UNS	66%	81%
8	mixed-bag-2024	274	272 OPT, 2 UNS	65%	81%
9	roundingsat+pbsuma-opt-log	270	1 OPT, 267 OPTC, 2 UNSC	64%	79%
10	IPBHS-GUROBI-SYM	269	267 OPT, 2 UNS	64%	79%

OPT-LIN ranking, instances supported by all solvers

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 420					
Virtual Best Solver (VBS)		340	334 OPT, 6 UNS	81%	100%
11	IPBHS-GUROBI	268	266 OPT, 2 UNS	64%	79%
12	roundingsat+pbsuma-opt	266	264 OPT, 2 UNS	63%	78%
13	roundingsat-ls+pbsuma-log	262	260 OPTC, 2 UNSC	62%	77%
14	roundingsat-ls+pbsuma	258	256 OPT, 2 UNS	61%	76%
15	LSIPExact *S1*	254	251 OPT, 3 UNS	60%	75%
16	IPBHS-SCIP	249	247 OPT, 2 UNS	59%	73%
17	LSIPExact 20 cores *S1*	245	242 OPT, 3 UNS	58%	72%
18	ExactNoDomBrk	245	243 OPT, 2 UNS	58%	72%
19	Exact	244	242 OPT, 2 UNS	58%	72%
20	ExactNoDbNoLS	243	241 OPT, 2 UNS	58%	71%
21	ExactPR	242	240 OPT, 2 UNS	58%	71%
22	WMaxCDCL-SCIP	242	240 OPT, 2 UNS	58%	71%
23	SCIP *24*	236	232 OPT, 4 UNS	56%	69%
24	SCIP *25*	235	231 OPT, 4 UNS	56%	69%

OPT-LIN ranking, instances supported by all solvers

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 420					
Virtual Best Solver (VBS)		340	334 OPT, 6 UNS	81%	100%
25	UWrMaxSat	227	225 OPT, 2 UNS	54%	67%
26	CASHWMaxSATDisjCad-S	225	223 OPT, 2 UNS	54%	66%
27	OR-Tools	224	222 OPT, 2 UNS	53%	66%
28	Exact_proof	223	39 OPT, 182 OPTC, 2 UNSC	53%	66%
29	CASHWMaxSATDisjCom-S	222	220 OPT, 2 UNS	53%	65%
30	LSIPExact *S2*	221	219 OPT, 2 UNS	53%	65%
31	pb-oll-rs-2024	208	206 OPT, 2 UNS	50%	61%
32	LSIPExact 20 cores *S2*	193	191 OPT, 2 UNS	46%	57%
33	NaPS	192	190 OPT, 2 UNS	46%	56%
34	pb_picat	179	176 OPT, 3 UNS	43%	53%
35	roundingsat-ihs	162	160 OPT, 2 UNS	39%	48%
36	roundingsat-ihs-log	162	1 OPT, 159 OPTC, 2 UNSC	39%	48%

OPT-LIN ranking, instances supported by all solvers

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 420					
Virtual Best Solver (VBS)		340	334 OPT, 6 UNS	81%	100%
37	toulbar2	114	113 OPT, 1 UNS	27%	34%
38	Sat4j Resolution	112	110 OPT, 2 UNS	27%	33%
39	Sat4j Res VeriPB	112	5 OPT, 105 OPTC, 2 UNSC	27%	33%
40	Sat4j CP VeriPB	109	108 OPTC, 1 UNSC	26%	32%
41	Sat4j CP	87	87 OPT	21%	26%
42	Hybrid-NuPBODeepOptS-ExactPRnols	0		0%	0%
43	NuPBO-DeepOpt+	0		0%	0%
44	NuPBO-DeepOptS+	0		0%	0%
45	PRINTEMPS	0		0%	0%
46	PRINTEMPS **20 cores**	0		0%	0%

DEC-LIN: comparing the 2 rankings

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 502					
Virtual Best Solver (VBS)		468	165 SAT, 303 UNS	93%	100%
1	SCIP-NaPS	406	147 SAT, 259 UNS	81%	87%
2	*OR-Tools* **20 cores**	405	139 SAT, 266 UNS, **1 NS**	81%	87%
3	Hybrid-CASHWMaxSATDisjCadS+SynLSCD	404	140 SAT, 264 UNS	80%	86%
4	LSIPExact *S1*	402	131 SAT, 271 UNS, **1 NS**	80%	86%
5	Hybrid-CASHWMaxSATDisjComS+SynLSCD	392	132 SAT, 260 UNS	78%	84%

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 472					
Virtual Best Solver (VBS)		439	165 SAT, 274 UNS	93%	100%
1	Hybrid-CASHWMaxSATDisjCadS+SynLSCD	390	140 SAT, 250 UNS	83%	89%
2	SCIP-NaPS	389	147 SAT, 242 UNS	82%	89%
3	LSIPExact *S1*	389	131 SAT, 258 UNS	82%	89%
4	*OR-Tools* **20 cores**	386	139 SAT, 247 UNS	82%	88%
5	Hybrid-CASHWMaxSATDisjComS+SynLSCD	379	132 SAT, 247 UNS	80%	86%

OPT-LIN: comparing the 2 rankings

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 555					
Virtual Best Solver (VBS)		439	415 OPT, 24 UNS	79%	100%
1	UWrMaxSat-SCIP	358	339 OPT, 19 UNS	65%	82%
2	Hybrid-CASHWMaxSATDisjCom+ExactPRS9	357	337 OPT, 20 UNS	64%	81%
3	Hybrid-CASHWMaxSATDisjCad+ExactPRS	356	336 OPT, 20 UNS	64%	81%
4	Hybrid-CASHWMaxSATDisjCom+ExactPRS	354	334 OPT, 20 UNS	64%	81%
5	*OR-Tools* **20 cores**	352	333 OPT, 19 UNS, **9 NS**	63%	80%

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 420					
Virtual Best Solver (VBS)		340	334 OPT, 6 UNS	81%	100%
1	Hybrid-CASHWMaxSATDisjCom+ExactPRS9	289	286 OPT, 3 UNS	69%	85%
2	Hybrid-CASHWMaxSATDisjCad+ExactPRS	287	284 OPT, 3 UNS	68%	84%
3	Hybrid-CASHWMaxSATDisjCom+ExactPRS	286	283 OPT, 3 UNS	68%	84%
4	UWrMaxSat-SCIP	285	283 OPT, 2 UNS	68%	84%
5	ExactPR-S *2025-06-01*	280	277 OPT, 3 UNS	67%	82%

Rankings in the CERT tracks

DEC-LIN-CERT ranking

Note: roundingsat is the only solver using the unchecked deletion mode of VeriPB.

Rank	Solver	#solved	Detail	%inst.
Ranking that includes uncertified answers.				
1	roundingsat+pbsuma-log	387	128 SAT, **1 UNS**, 258 UNSC	77%
2	roundingsat-ls-log	380	127 SAT, 253 UNSC	76%
3	roundingsat-log	371	113 SAT, 258 UNSC	74%
4	Exact_proof	365	116 SAT, **15 UNS**, 234 UNSC	73%
5	Sat4j Res VeriPB	260	103 SAT, 157 UNSC	52%
6	Sat4j CP VeriPB	243	68 SAT, 175 UNSC	48%

Ranking that excludes uncertified answers.				
1	roundingsat+pbsuma-log	386	128 SAT, 258 UNSC	77%
2	roundingsat-ls-log	380	127 SAT, 253 UNSC	76%
3	roundingsat-log	371	113 SAT, 258 UNSC	74%
4	Exact_proof	350	116 SAT, 234 UNSC	70%
5	Sat4j Res VeriPB	260	103 SAT, 157 UNSC	52%
6	Sat4j CP VeriPB	243	68 SAT, 175 UNSC	48%

OPT-LIN-CERT ranking

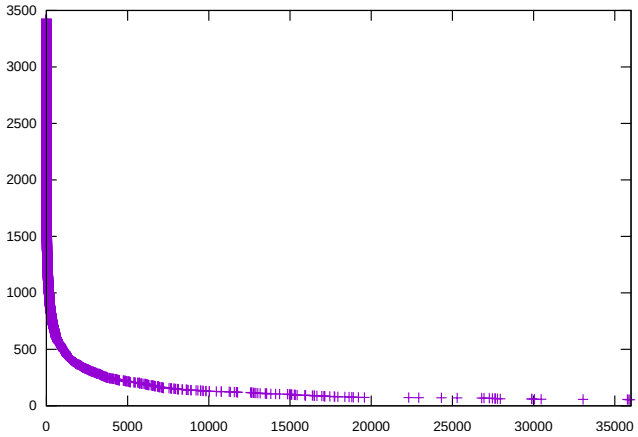
Note: roundingsat is the only solver using the unchecked deletion mode of VeriPB.

Rank	Solver	#solved	Detail	%inst.
Ranking that includes uncertified answers.				
1	roundingsat+pbsuma-opt-log	329	**1 OPT**, 310 OPTC, 18 UNSC	59%
2	roundingsat-ls+pbsuma-log	323	305 OPTC, 18 UNSC	58%
3	Exact_proof	285	**51 OPT**, 214 OPTC, 20 UNSC	51%
4	roundingsat-ihs-log	200	**1 OPT**, 182 OPTC, 17 UNSC	36%
5	Sat4j Res VeriPB	149	**6 OPT**, 127 OPTC, 16 UNSC	27%
6	Sat4j CP VeriPB	135	121 OPTC, 14 UNSC	24%

Ranking that excludes uncertified answers.				
1	roundingsat+pbsuma-opt-log	328	310 OPTC, 18 UNSC	59%
2	roundingsat-ls+pbsuma-log	323	305 OPTC, 18 UNSC	58%
3	Exact_proof	234	214 OPTC, 20 UNSC	42%
4	roundingsat-ihs-log	199	182 OPTC, 17 UNSC	39%
5	Sat4j Res VeriPB	143	127 OPTC, 16 UNSC	26%
6	Sat4j CP VeriPB	135	121 OPTC, 14 UNSC	24%

CERT tracks: verification time

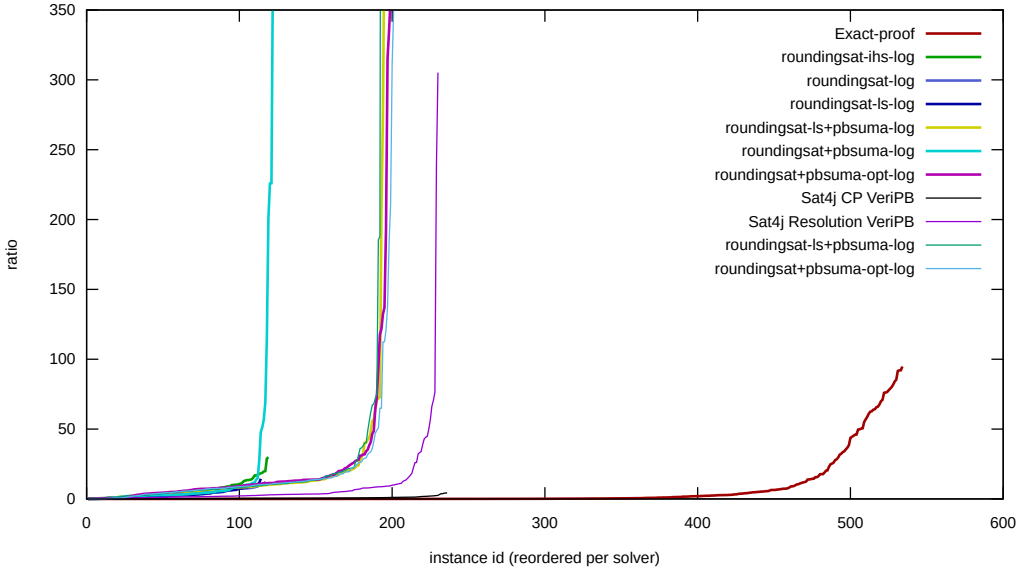
Only 0.76 % of proofs verified in more than 5 hours.



time (hours)	# verified
[0, 0.25]	2894
(0.25, 0.5]	150
(0.5, 1]	121
(1, 2]	100
(2, 3]	34
(3, 4]	21
(4, 5]	24
(5, 6]	6
(6, 7]	3
(7, 8]	9
(8, 9]	4
(9, 10]	4
TO	53

y = number of proofs certified in more than x seconds
= number of proofs that can't be checked within x seconds

CERT tracks: verification time/search time (max ratio=2387)



PARTIAL-LIN ranking

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 208					
Virtual Best Solver (VBS)		201	200 MOPT, 1 UNS	97%	100%
1	OR-Tools	172	172 MOPT	83%	86%
2	SCIP *24*	159	158 MOPT, 1 UNS	76%	79%
3	Exact	158	157 MOPT, 1 UNS	76%	79%
4	ExactNoDomBrk	157	156 MOPT, 1 UNS	75%	78%
5	NaPS	146	145 MOPT, 1 UNS	70%	73%
6	toulbar2	144	143 MOPT, 1 UNS	69%	72%
7	Sat4j Resolution	133	132 MOPT, 1 UNS	64%	66%
8	Sat4j CP	115	115 MOPT	55%	57%
9	PRINTEMPS	0	incomplete	0%	0%

Benchmarks selection

- DEC-LIN:
  - 81 % of the instances solved by the best solver (VBS solves 93 %)
  - Many solvers have a median CPU time of 10 seconds or less.
- OPT-LIN:
  - 65 % of the instances solved by the best solver (VBS solves 79 %)
  - Many solvers have a median CPU time of 10 seconds or less.
- All old benchmarks considered in the purely random selection.
- It's probably time for a better selection or filtering of the instances.
- The community will have to decide for the next competition.

Take home message

Benefits of a competition:

- evaluate solvers in the same conditions
- help collecting publicly available benchmarks in one place
- help identifying new solvers and new ideas on the market
- help debug solvers and verifiers

Caveats:

- don't take the rankings too seriously!
- the set of instances does matter (obviously)!
- the information collected cannot be reduced to a simple ranking.
- **there are many different ways to look at the results!**

More information

- All details are on the web site **https://www.cril.univ-artois.fr/PB25/**
- Questions can be addressed to the organizer: roussel @ cril . fr.
- Thanks to all participants and submitters!
- Feedback will be collected to improve the next edition. Contestants were asked to participate, but anyone interested may contribute too. The question of the benchmarks selection has to be addressed.
- **Next competition in 2026.**
- Keep in mind that a competition cannot exist without both solvers and benchmarks!
- Write solvers, generate instances, be ready to submit!
- Entering the competititon is free! The only price to pay is that any result of the competition becomes public in the end.

Links

- PB25: https://www.cril.univ-artois.fr/PB25/
- VeriPB: https://gitlab.com/MIAOresearch/software/VeriPB
- CakePB: https://gitlab.com/MIAOresearch/software/cakepb