

The SAT 2005 Competition

What's new this year

The benchmarks

First stage results

- All categories
- Random category
- Crafted category
- Industrial category

Second stage results

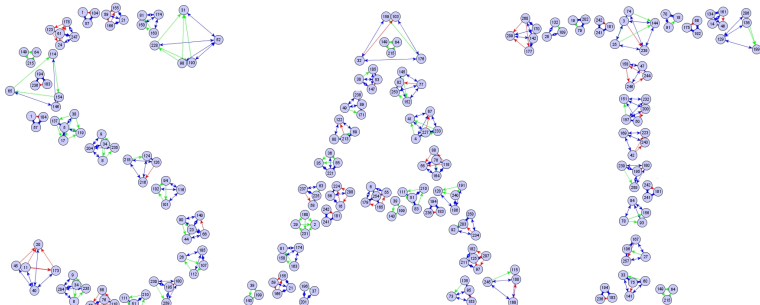
- Random category
- Crafted category
- Industrial category

Certified UNSAT
Special track

Non clausal special track

Next contest?

Pseudo Boolean evaluation



The SAT 2005 Competition Fourth Edition

Daniel Le Berre and Laurent Simon

Eighth International Conference on Theory and
Applications of Satisfiability Testing, SAT'05

Agenda

What's new this year

The benchmarks

First stage results

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Random category

Crafted category

Industrial category

Second stage results

Random category

Crafted category

Industrial category

Certified UNSAT Special track

Non clausal special track

Next contest?

Pseudo Boolean evaluation

What's new this
year

The benchmarks

First stage results

All categories

Random category

Crafted category

Industrial category

Second stage
results

Random category

Crafted category

Industrial category

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track

Next contest?

Pseudo Boolean
evaluation

They support us
Thank you!

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year

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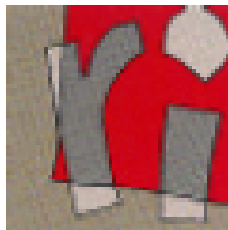
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Non clausal special
track

Next contest?

Pseudo Boolean
evaluation



The new judges

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
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Next contest?

Pseudo Boolean
evaluation

Armin Biere Specialist about industrial benchmarks and solvers.

Olivier Kullmann Specialist about k-SAT. Generated all the benchmarks for the random category.

Allen van Gelder Well aware of the CASC competition. Proposed the new scoring scheme. Managed the certified unsat special track.

All the decisions were taken in agreement with the judges

The special tracks

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

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Pseudo Boolean
evaluation

Certified UNSAT a specific category in which the solvers must output a certificate of unsatisfiability. The proof format and a proof checker were provided by Allen van Gelder. Only two participants: zchaff and ttsp-3.0

Pseudo Boolean evaluation dedicated to solvers managing pseudo-boolean constraints and optimization functions. Managed by Vasco Manquinho and Olivier Roussel
<http://www.cril.univ-artois.fr/PB05/>
8 solvers (17 variants) from 8 submitters.

Non clausal evaluation dedicated to solvers able to take gates as input. The input format was provided by Fahiem Bacchus and Toby Walsh. No solver submission. One benchmark submission.

What's new in the rules

What's new this year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage results

Random category
Crafted category
Industrial category

Certified UNSAT Special track

Non clausal special track

Next contest?

Pseudo Boolean evaluation

- ▶ **Competition** and **Demonstration** divisions.
Competition the source code of the solver must be available after the competition.
Demonstration a binary version of the solver must be available for research purpose.
- ▶ Participation to the competition must benefit to the community
 - ▶ By providing source code, binary or benchmarks
 - ▶ By supporting the conference and the competition

The new scoring scheme

What's new this
year

The benchmarks

First stage results

- All categories
- Random category
- Crafted category
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Pseudo Boolean
evaluation

Benchmark purse to be divided equally among the solvers able to solve it.

Speed purse to be divided unequally among the solvers able to solve a given benchmark.

Series an extra credit is given for each series solved.

Solver his score is the sum of the credits obtained per benchmarks solved.

The new award scheme

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

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Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

- ▶ Three **categories**: industrial, crafted and random
- ▶ Three **specialties**: SAT, UNSAT and SAT+UNSAT
- ▶ Three **medals**: gold, silver and bronze

So we have a total of **27** awards this year!

What's new this
year

The benchmarks

First stage results

All categories
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Crafted category
Industrial category

Second stage
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Crafted category
Industrial category

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Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

- ▶ Only 3 solvers per submitter can enter the first stage, competition division.
- ▶ Only 1 solver per submitter can enter the second stage, competition division.

Random category

What's new this
year

The benchmarks

First stage results

All categories
Random category
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Industrial category

Second stage results

Random category
Crafted category
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Non clausal special
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Next contest?

Pseudo Boolean
evaluation

- ▶ 3-SAT, 5-SAT, 7-SAT
- ▶ From 400 to 10000 variables.
- ▶ 285 SAT and 105 UNSAT benchmarks
- ▶ Answers known in advance

Industrial category

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

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Random category
Crafted category
Industrial category

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Non clausal special track

Next contest?

Pseudo Boolean evaluation

Zarpas New formal verification benchmarks from IBM
(FV_2004)

Velev Known VLIW-SAT (2.0 and 4.0),
VLIW-UNSAT 2.0 and Liveness UNSAT 2.0

Grieu VMPC inversion, open cryptographic problem

Narain VPN models generated from Alloy

Maris Planning benchmarks

Wider range of problems than in previous edition.

Crafted category

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year

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Crafted category
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Pseudo Boolean
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Sat'04 Previous year hard, unsolved benchmarks

Biere LinvRinv benchmarks (proposed by Cook last
year)

Sabharwal Counting/Ordering/Pebbling problems

Jarvisalo Based on 3-Regular graphs

Lynce Social Golfer problem (A golf problem in St
Andrews?)

Sorge Algebraic benchmarks

Markstrom Problems generating long learned clauses.

Roussel PHNF form of previous year medium
benchmarks

Wider range of problems than in previous edition.

Environment

What's new this
year

The benchmarks

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All categories
Random category
Crafted category
Industrial category

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results

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Crafted category
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Next contest?

Pseudo Boolean
evaluation

The hardware:

LRI 16 Athlon 1800+ with 1GB RAM

UC 8 Athlon 1800+ with 2 GB RAM

32 Pentium III 450 with 1GB of RAM

- ▶ Running GNU Linux (RH flavor).
- ▶ Solvers compiled with GCC 3.3.5.
- ▶ Java solver using Java 1.5.0_02 JVM.

Provided by:

- ▶ LINC Lab, Department of ECECS, University of Cincinnati
- ▶ LRI, Université de Paris-Sud

The first stage

What's new this
year

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results

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Crafted category
Industrial category

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Special track

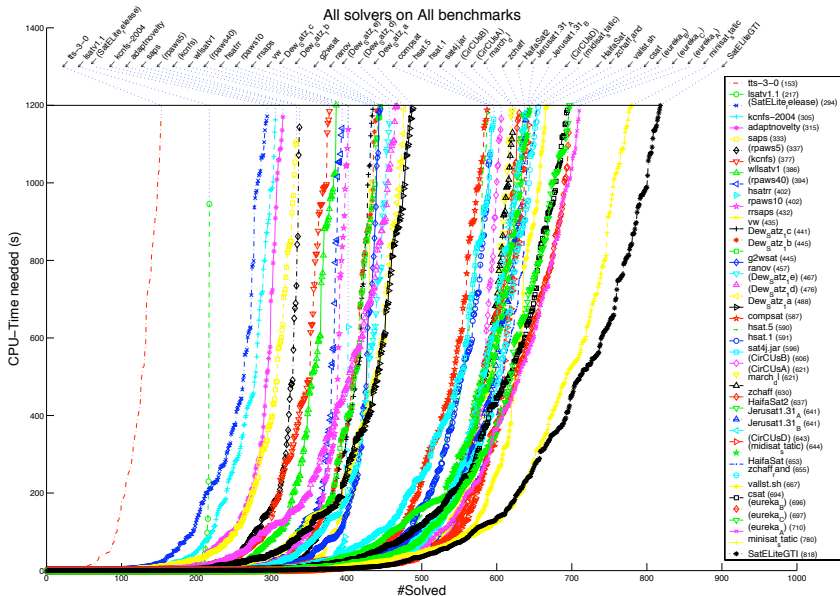
Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

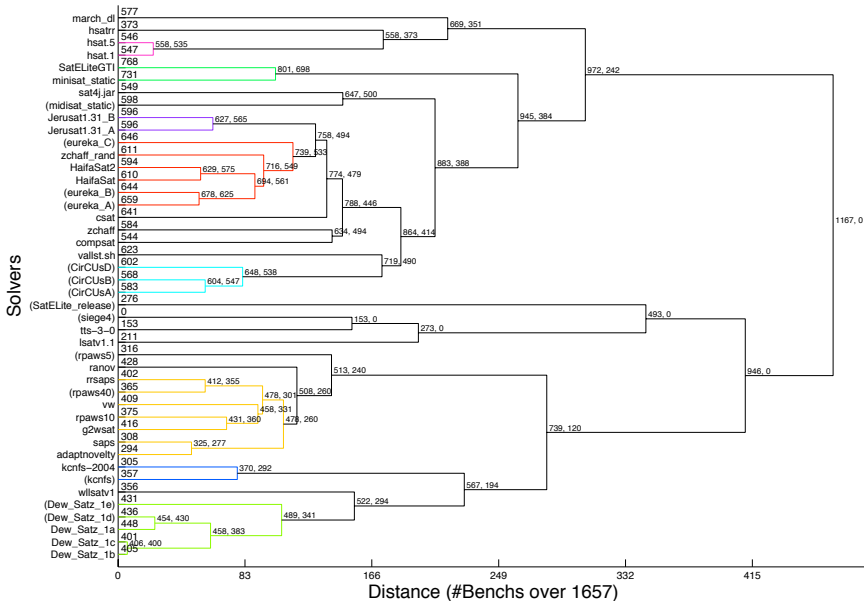
- ▶ Aim: to detect the most promising solvers for a given (category, specialty)
- ▶ 20 minutes timeout (**Greater than in previous years**)
- ▶ Solvers answering incorrectly move to demonstration division

Overview on all the benchmarks (see posters)

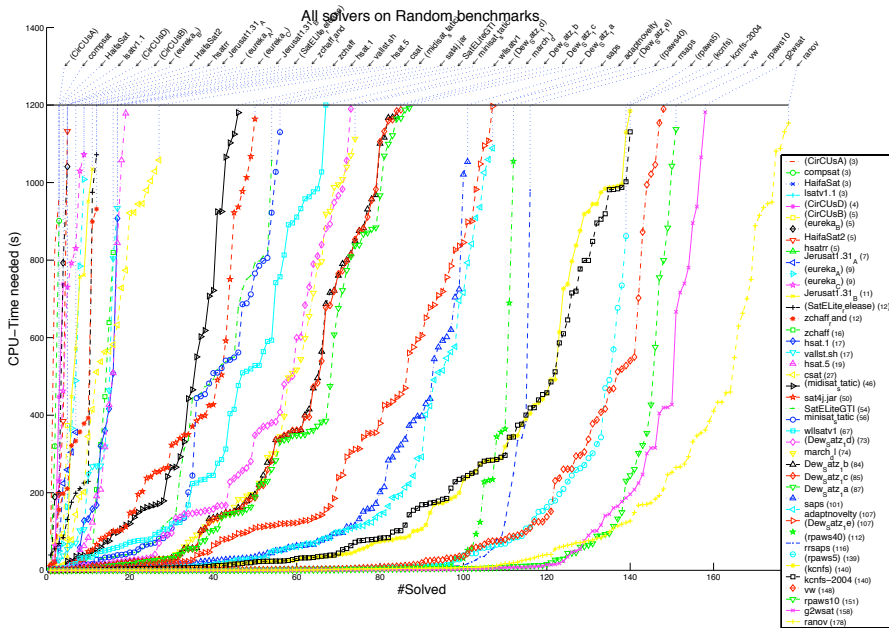


Clustering on all the benchmarks

SAT 2005 Clustering of all solvers on all benchmarks

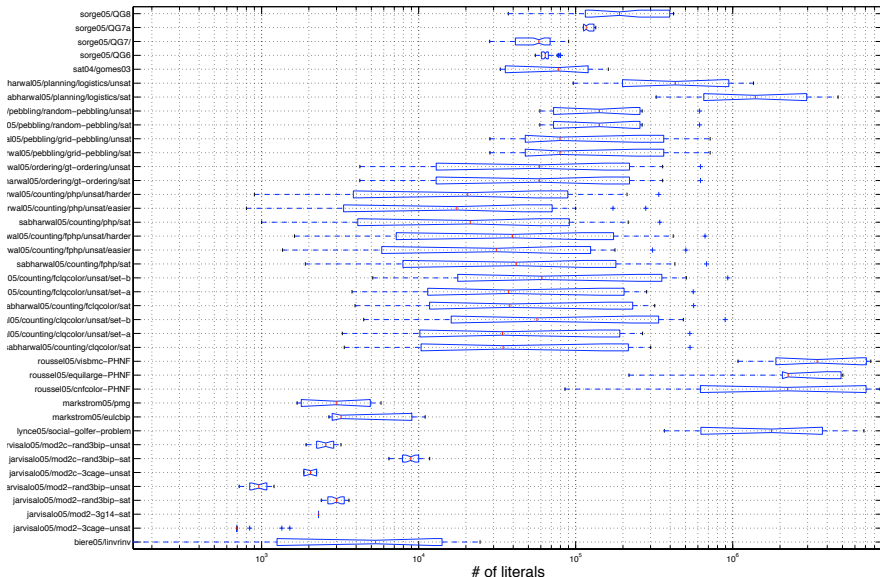


Overview of the solvers on random benchmarks

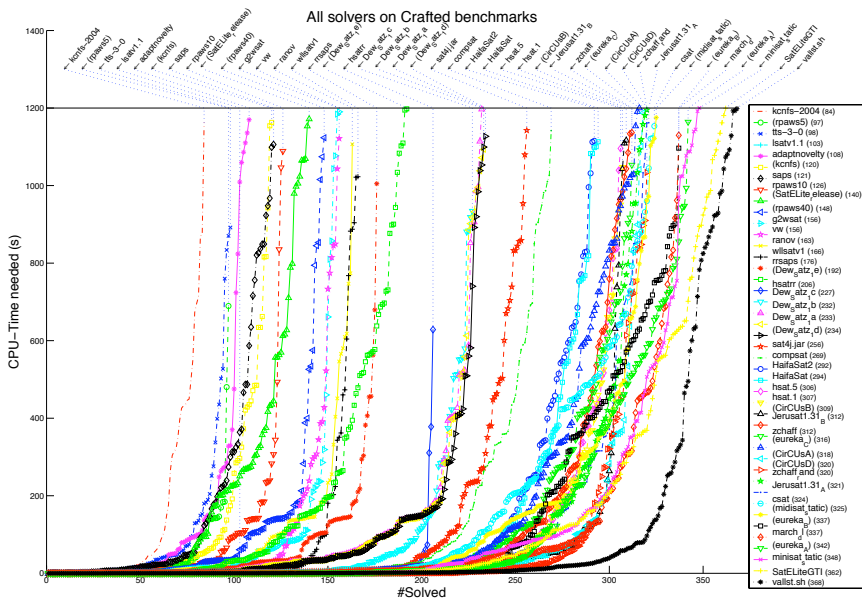


Overview of the size of crafted benchmarks

Distribution of the sizes of crafted benchmarks

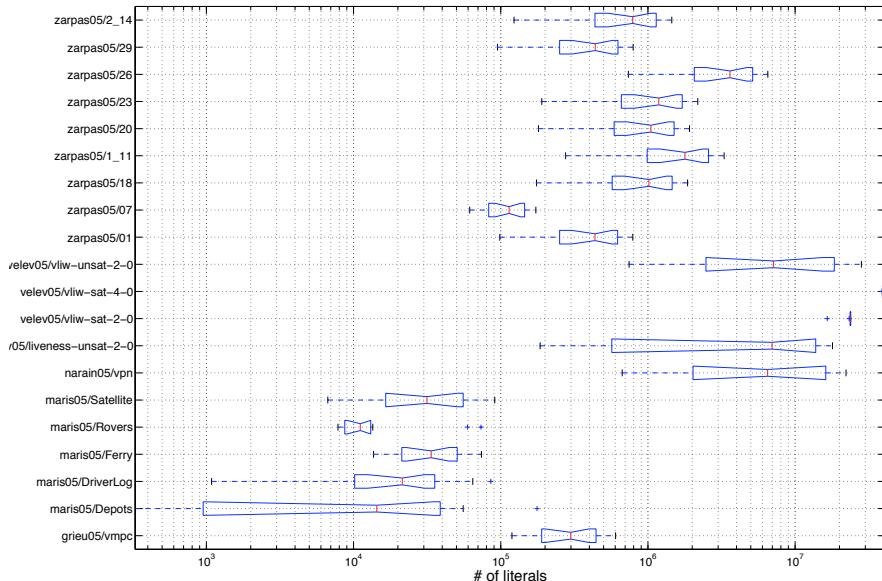


Overview of the solvers on crafted benchmarks

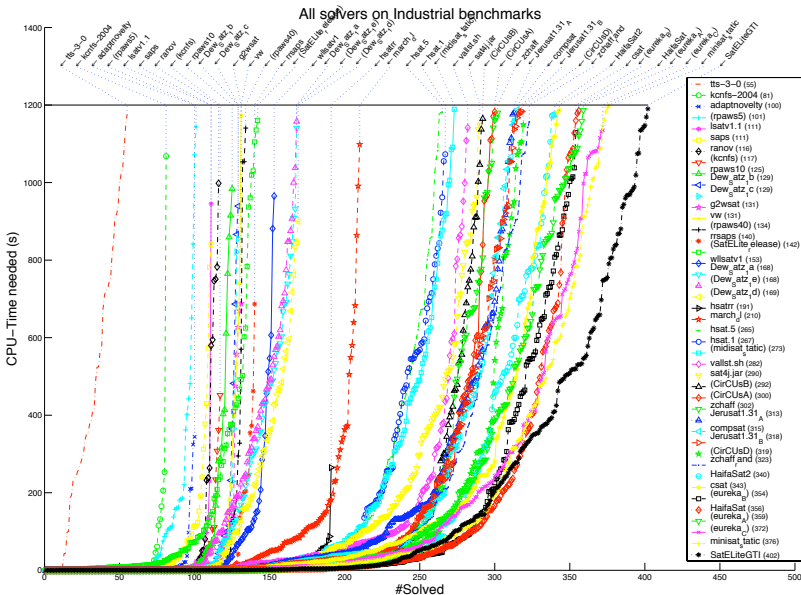


Overview of the size of industrial benchmarks

Distribution of the sizes of industrial benchmarks



Overview of the solvers on industrial benchmarks



The second stage

What's new this
year

The benchmarks

First stage results

- All categories
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- Industrial category

Second stage
results

- Random category
- Crafted category
- Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

What's new this
year

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First stage results

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- Industrial category

Second stage
results

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- Crafted category
- Industrial category

Certified UNSAT
Special track

Non clausal special
track

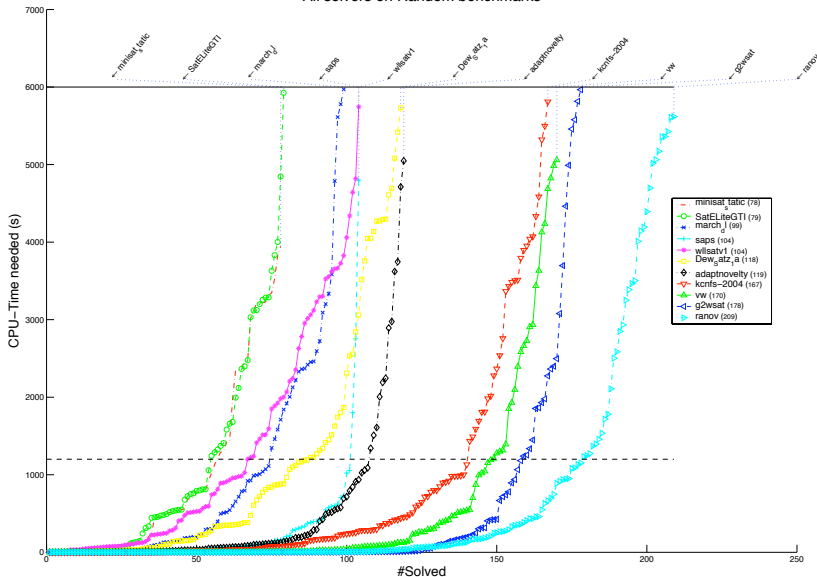
Next contest?

Pseudo Boolean
evaluation

The final results

Overview of the solvers on random benchmarks

Second Stage:
All solvers on Random benchmarks



Random SAT specialty, the winners

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

1. ranov

2. g2wsat

3. vw

Random SAT specialty, the winners

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
ranov	163903	209	0
g2wsat	101286	178	0
vw	76002	170	0
adaptnovelty	21748	119	0
saps	15603	104	0
kcnfs-2004	14604	92	0
dSatz-1a	8943	68	0
march-dl	7444	56	0
wllsatv1	7202	59	0
satELiteGTI	5198	46	0
minisat	5147	45	0

What's new this
year

The benchmarks

First stage results

- All categories
- Random category
- Crafted category
- Industrial category

Second stage
results

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- Crafted category
- Industrial category

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Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

1. **kcnfs-2004**
2. march-dl
3. sSatz-1a

UNSAT specialty, the complete ranking

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
kcnfs-2004	97930	0	75
march-dl	25228	0	43
dewSatz-1a	19456	0	50
wllsatv1	12902	0	45
minisat	7369	0	33
satELiteGTI	7335	0	33

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

1. kcnfs-2004
2. march-dl
3. sSatz-1a

Random SAT+UNSAT specialty, the complete ranking

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

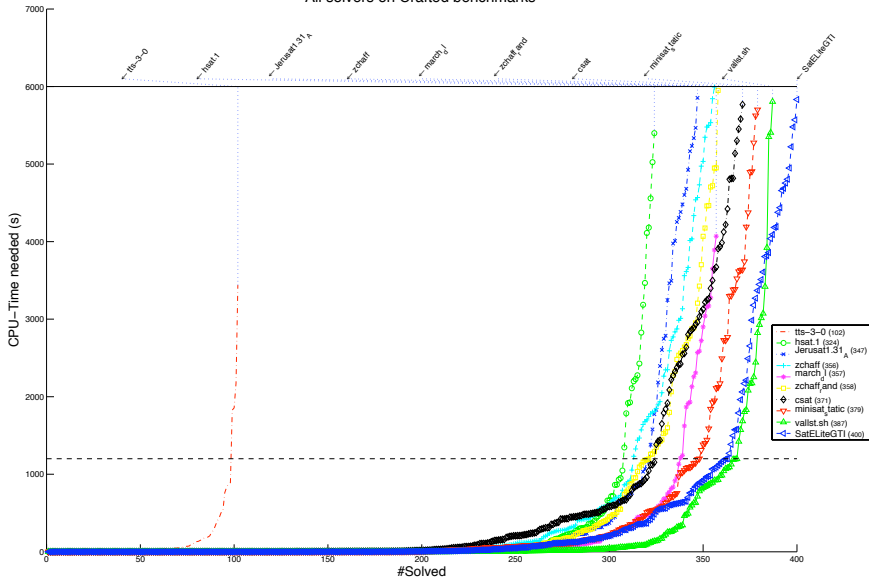
Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
kcnfs-2004	95075	92	75
march-dl	27141	56	43
dSatz-1a	22940	68	50
wllsatv1	16145	59	45
satELiteGTI	10074	46	33
minisat	10058	45	33

Overview of the solvers on crafted benchmarks

based on a selection of the first stage benchmarks

Second Stage:
All solvers on Crafted benchmarks



Crafted SAT specialty, the winners

What's new this
year

The benchmarks

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- Industrial category

Second stage
results

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- Crafted category
- Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

1. **vallst**
2. march-dl
3. hsat-1

Crafted SAT specialty, the complete ranking

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
vallst	31258	138	0
march-dl	27656	138	0
hsat-1	20156	130	0
satELiteGTI	17418	122	0
minisat	17210	122	0
csat	13791	113	0
zchaff	13692	112	0
zchaff-rand	11431	107	0
jerusat-A	10702	104	0
tts	475	5	0

What's new this
year

The benchmarks

First stage results

- All categories
- Random category
- Crafted category
- Industrial category

Second stage
results

- Random category
- Crafted category
- Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

1. satEliteGTI
2. minisat
3. vallst and march-dl

Crafted UNSAT specialty, the complete ranking

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
satELiteGTI	35639	0	126
minisat	26159	0	121
vallst	25532	0	100
march-dl	25371	0	99
csat	23878	0	112
tts-3-0	20765	0	54
hsat-1	19936	0	90
zchaff	14359	0	89
zchaff-rand	12419	0	78
jerusat-A	9275	0	77

What's new this
year

The benchmarks

First stage results

- All categories
- Random category
- Crafted category
- Industrial category

Second stage
results

- Random category
- Crafted category
- Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

1. **vallst**
2. satEliteGTI
3. march-dl

Crafted SAT+UNSAT specialty, the complete ranking

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

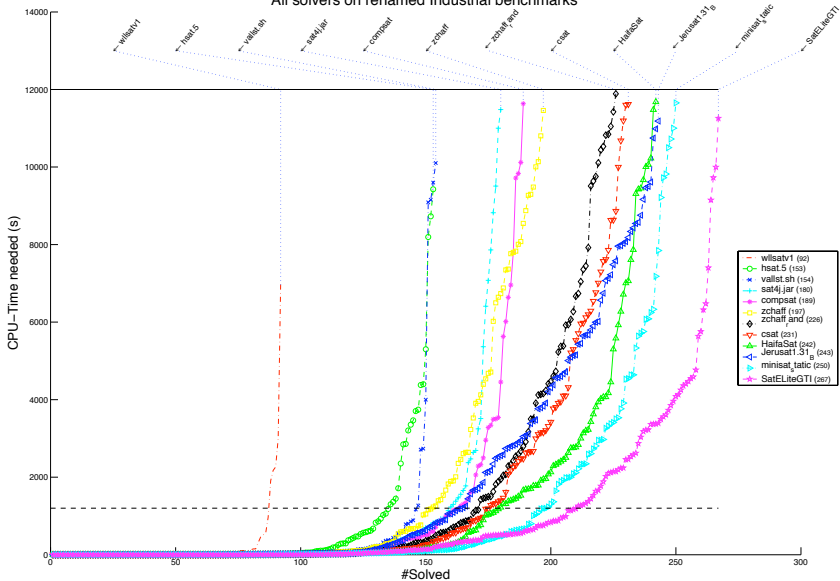
Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
vallst	56445	138	100
satELiteGTI	53128	122	126
march-dl	52432	138	99
minisat	43691	122	121
hsat-1	39497	130	90
csat	38324	113	112
zchaff	27455	112	89
zchaff-rand	24171	107	78
tts-3-0	21298	5	54
jerusat-A	19632	104	77

Overview of the solvers on original industrial benchmarks

Second Stage:

All solvers on renamed Industrial benchmarks



What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

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Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

1. satEliteGTI
2. minisat
3. jerusat-B and haifaSat

Industrial SAT Specialty, the complete ranking

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
satELiteGTI	73506	180	0
minisat	50985	166	0
jerusat-B	38625	163	0
haifaSat	28428	151	0
zchaff-rand	24885	132	0
csat	21997	140	0
zchaff	19236	121	0
compsat	16715	114	0
sat4j	12898	110	0
wllsatv1	11390	86	0
hsat-5	11046	99	0
vallst	7757	85	0

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
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Non clausal special
track

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Pseudo Boolean
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1. **satEliteGTI**
2. zchaff-rand
3. haifaSat

Industrial UNSAT specialty, the complete ranking

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

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Pseudo Boolean
evaluation

Solver	Score	SAT answers	UNSAT answers
satELiteGTI	27518	0	87
zchaff-rand	26792	0	94
haifaSat	23666	0	91
minisat	19863	0	84
csat	15892	0	91
zchaff	13829	0	76
jerusat-B	10225	0	80
hsat-5	10029	0	54
vallst	9192	0	69
compsat	9097	0	75
sat4j	8654	0	70
wllsatv1	1053	0	6

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year

The benchmarks

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Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

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Non clausal special
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Pseudo Boolean
evaluation

1. satEliteGTI
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3. zchaff-rand and haifaSat

SAT+UNSAT specialty, the complete ranking

What's new this
year

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Crafted category
Industrial category

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Solver	Score	SAT answers	UNSAT answers
ssatELiteGTI	99662	180	87
minisat	69485	166	84
haifaSat	50931	151	91
zchaff-rand	50515	132	94
jerusat-B	47487	163	80
csat	36526	140	91
compsat	25399	114	75
zchaff	31702	121	76
sat4j	21097	110	70
hsat-5	20995	99	54
vallst	16874	85	69
wllsatv1	12467	86	6

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The proof format

All that job was done by Allen van Gelder

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Pseudo Boolean
evaluation

- ▶ For each benchmarks bench found unsat. a proof file bench.proof must be given.

- ▶ There are two possibilities for the proof format:

Resolution format Each resolution steps are provided
and resolvants are explicitly provided.

Trace format Only the resolution steps are provided.
Not the resolvants. More compact format.

- ▶ A checker can check a proof using the resolution format.
- ▶ The trace format can be converted into the resolution format.

Examples of the proof formats

Example (Original input file)

```
p cnf 2 3
1 -2 0
1 2 0
-1 0
```

Example (possible proof, resolution format)

```
4 2 1 2 2 1 1 2
5 1 3 4 0 0
```

Example (possible proof, trace format)

```
4 2 1 2
5 1 3 4
```

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Industrial category

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Non clausal special
track

Next contest?

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The contestants

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year

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Pseudo Boolean
evaluation

zchaff Use the resolution format

ttsp Use the trace format

- ▶ The solvers behave quite differently: only **21** benchmarks are found unsat by both solvers.
- ▶ They do not use the same output format.

Zchaff vs TTS: running time

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Pseudo Boolean
evaluation

	TTS				ZCHAFF			
CPU Time	CERT	ORIG	Cost	Size	CERT	ORIG	Cost	Size
sat05-561	0,01	0,02	-50,00	5	0	0	-25,01	7
sat05-562	6,83	4,38	55,94	415	0,09	0,01	633,33	982
sat05-1273	(471,36)	286,59	64,47		12,55	8,42	49,13	54066
sat05-1171	1,4	1,36	2,94	107	6,42	5,06	26,94	19907
sat05-1172	7,89	7,06	11,76	594	41,11	34,	19,84	91341
sat05-1185	2,15	1,87	14,97	245	6,28	5	25,66	15153
sat05-1186	12,26	9,71	26,26	1377	65,28	56,11	16,35	132093
sat05-1213	90,97	3,83	2275,20	9254	12,18	9,57	27,20	28493
sat05-1214	(403,76)	21,41	1785,85		45,39	40,07	13,29	84726
sat05-1227	(523,35)	6,69	7722,87		8,08	6,33	27,53	24433
sat05-1228	(600,91)	30,27	1885,17		60,79	50,88	19,50	102763
sat05-2308	143,54	7,76	1749,74	41533	30,23	26,4	14,51	43531
sat05-2309	(153,31)	7,56	1927,91		16,03	13,37	19,91	22741
sat05-2323	(162,45)	12,75	1174,12		85,7	69,31	23,65	53554
sat05-2325	(124,59)	12,78	874,88		232,9	195,33	19,23	91270
sat05-2594	7,93	0,96	726,04	5153	34,92	27,41	27,37	50009
sat05-2595	45,5	1,12	3962,50	16756	5,75	3,97	44,74	18110
sat05-2596	161,96	1,23	13067,48	49384	25,8	19,66	31,23	39092
sat05-2610	221,81	2,08	10563,94	61406	71,13	58,1	22,42	65084
sat05-2625	50,79	2,6	1853,46	27962	40,02	32,01	25,03	41484
sat05-2654	(196,8)	7,39	2563,06		205,39	174,87	17,45	89099

Size in KB.

Size of the Problems

What's new this
year

The benchmarks

First stage results

All categories
Random category
Crafted category
Industrial category

Second stage
results

Random category
Crafted category
Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

sat05-561 24 61

sat05-562 90 262

sat05-1273 116 1362

sat05-1171 80 370

sat05-1172 120 672

sat05-1185 90 415

sat05-1186 132 738

sat05-1213 80 650

sat05-1214 120 1212

sat05-1227 90 775

sat05-1228 132 1398

sat05-2308 120 480

sat05-2309 120 480

sat05-2323 140 560

sat05-2325 140 560

sat05-2594 90 240

sat05-2595 90 240

sat05-2596 90 240

sat05-2610 105 280

sat05-2625 120 320

sat05-2654 150 400

Zchaff certificates on easy UNSAT IBM benchmarks

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Pseudo Boolean
evaluation

Bench	Cert	Orig	Cost (%)	Size (KB)
01_SAT_dat.k10	0,9	0,23	284,19	12656
07_SAT_dat.k30	4,21	3,41	23,41	11353
07_SAT_dat.k35	5,11	4,29	19,02	11836
18_SAT_dat.k10	35,93	0,32	10957,58	(711381)
18_SAT_dat.k15	(103,42)	3,64	2743,20	-
1_11_SAT_dat.k10	3,59	0,64	462,38	54786
1_11_SAT_dat.k15	30,08	3,65	724,87	(525236)
20_SAT_dat.k10	3,02	0,29	931,40	54839
23_SAT_dat.k10	0,78	0,23	236,80	10251
23_SAT_dat.k15	(98,71)	1,23	7913,41	-
26_SAT_dat.k10	12,34	7,95	55,27	148
2_14_SAT_dat.k10	15,09	0,48	3017,36	(286783)
2_14_SAT_dat.k15	(102,2)	1,49	6778,59	-

Size of the "easy" IBM benchmarks

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Pseudo Boolean
evaluation

Benchmark	# var	# clauses	Size
01_SAT_dat.k10.cnf	9275	38802	12656
07_SAT_dat.k30.cnf	11081	31034	11353
07_SAT_dat.k35.cnf	12116	33469	11836
1_11_SAT_dat.k10.cnf	28280	111519	54786
(1_11_SAT_dat.k15.cnf)	44993	178110	(525236)
(18_SAT_dat.k10.cnf)	17141	69989	(711381)
—18_SAT_dat.k15.cnf—	25915	106325	
20_SAT_dat.k10.cnf	17567	72087	54839
(2_14_SAT_dat.k10.cnf)	12859	49351	(286783)
—2_14_SAT_dat.k15.cnf—	20302	78395	
23_SAT_dat.k10.cnf	18612	76086	10251
—23_SAT_dat.k15.cnf—	29106	119635	
26_SAT_dat.k10.cnf	55591	277611	148

The reasons for failure

What's new this
year

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Next contest?

Pseudo Boolean
evaluation

Input format discussable several standard format do exist for gate descriptions (netlists, trace format,...).

No benchmarks to play with the only benchmarks currently available in the edimacs format are the ones submitted for the special track.

No solver to play with There is currently no solver able to read the edimacs input format.

Next SAT contest?

What's new this
year

The benchmarks

First stage results

- All categories
- Random category
- Crafted category
- Industrial category

Second stage
results

- Random category
- Crafted category
- Industrial category

Certified UNSAT
Special track

Non clausal special
track

Next contest?

Pseudo Boolean
evaluation

Will be in 2007...
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The first pseudo boolean solver evaluation

What's new this
year

The benchmarks

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track

Next contest?

Pseudo Boolean
evaluation

To be presented by Olivier Roussel and Vasco Manquinho