

The Results of SAT Competition 2021

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SAT Solver Competitions

Goals

- Compilation of new challenging benchmarks
- Promotion of SAT solvers and their development
- Evaluation of current state-of-the-art solvers (“snapshot”)

Long tradition, starting from 1992

- 3 competitions in the 90s (1992, 1993, 1996)
- 14 SAT Competitions (2002–)
- 5 SAT Races (2006, 2008, 2010, 2015, 2019)
- 1 SAT Challenge (2012)

Key rules

- Certified results of unsatisfiability using DRAT proof logging
 - ▶ Instance is “not solved” if proof checker finds inconsistency in proof
- Disqualification of buggy solvers
 - ▶ Producing an incorrect model
 - ▶ Report UNSAT on a known satisfiable instance
- Mandatory solver descriptions + open source
- Ranking scheme: PAR-2
 - ▶ Favors solvers that are faster (not only count solved instances)
- BYOB (Bring Your Own Benchmarks)
 - ▶ At most 20 instances per participant are used

What is New This Year

Crypto Track

- Second Instantiation of *Application Track*
- Introduced in SAT Competition 2020 (Planning Track)
- Application Tracks are evaluated on an extra set of instances stemming from a single application domain

Special Innovation Price in Main Track

- Solver won *no price* in Main, Crypto, SAT or UNSAT Track
- Solver is part of the best performing k -Portfolio
- Portfolio of size k with lowest PAR-2 score of its VBS
- Determined smallest k to find such a solver

Benchmark Instance Selection I

Submissions

- 1091 instance submitted
- 952 after “hardness” filter (solved by Minisat within one minute)
 - ▶ 352 instances for Main Track
 - ▶ 600 instances for Crypto Track

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Main Selection: 400 instances

139 SAT, 139 UNSAT, 122 UNKNOWN

- 300 new instances (24 instance families)
 - ▶ 13 instances per author (incl. unused from 2020)
 - ▶ 104 SAT, 74 UNSAT, 122 UNKNOWN
- 100 old instances (30 instance families)
 - ▶ 35 SAT, 65 UNSAT

Benchmark Instance Selection II

Submissions

- 1091 instance submitted
- 952 after “hardness” filter (solved by Minisat within one minute)
 - ▶ 352 instances for Main Track
 - ▶ 600 instances for Crypto Track

Benchmark Instance Selection II

Submissions

- 1091 instance submitted
- 952 after “hardness” filter (solved by Minisat within one minute)
 - ▶ 352 instances for Main Track
 - ▶ 600 instances for Crypto Track

Crypto Selection: 200 instances

151 SAT, 11 UNSAT, 38 UNKNOWN

- 115 new instances (3 authors)
- 85 old instances (14 authors)

Tracks part 1

■ Main (Sequential) Track (48 solvers)

- ▶ 400 benchmarks, a combination of “application” and “crafted”
- ▶ 5,000 sec limit for solving and 40,000 sec for proof checking
- ▶ Solvers run on a single core
- ▶ UNSAT proof logging required

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■ Parallel Track (10 solvers)

- ▶ The same 400 benchmarks from Main track
- ▶ 5,000 sec limit for solving
- ▶ 1 AWS m4.16xlarge: 64 virtual CPU cores, 256GB RAM

Tracks part 1

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■ Parallel Track (10 solvers)

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- ▶ 5,000 sec limit for solving
- ▶ 1 AWS m4.16xlarge: 64 virtual CPU cores, 256GB RAM

■ Cloud Track (6 solvers)

- ▶ The same 400 benchmarks from Main track
- ▶ 1,000 sec limit for solving
- ▶ 100 AWS m4.4xlarge: total of 1600 virtual CPU cores

Tracks part 2

- CaDiCaL Hack Track (5 solvers)
 - ▶ 400 benchmarks, a combination of “application” and “crafted”
 - ▶ 5,000 sec limit for solving and 40,000 sec for proof checking
 - ▶ Solvers run on a single core
 - ▶ UNSAT proof logging required

Tracks part 2

■ CaDiCaL Hack Track (5 solvers)

- ▶ 400 benchmarks, a combination of “application” and “crafted”
- ▶ 5,000 sec limit for solving and 40,000 sec for proof checking
- ▶ Solvers run on a single core
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■ Crypto Track (48 solvers)

- ▶ 200 benchmarks, all coming from cryptographic problems
- ▶ 5,000 sec limit for solving

Tracks part 2

- **CaDiCaL Hack Track (5 solvers)**
 - ▶ 400 benchmarks, a combination of “application” and “crafted”
 - ▶ 5,000 sec limit for solving and 40,000 sec for proof checking
 - ▶ Solvers run on a single core
 - ▶ UNSAT proof logging required
- **Crypto Track (48 solvers)**
 - ▶ 200 benchmarks, all coming from cryptographic problems
 - ▶ 5,000 sec limit for solving
- **No-Limit Track (52 solvers, superset of Main track participants)**
 - ▶ 300 brand new benchmarks (subset of the Main Track benchmarks)
 - ▶ 5,000 sec limit for solving
 - ▶ Most of the solvers provided source codes and models, but not all
 - ▶ No awards: top solvers were open source and proof producing

Parallel Track SAT – Results

The Top 3 solvers of the Parallel Track SAT are:

Parallel Track SAT – Results

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- 3 **Mallob-Parallel** (PAR-2: 2084, 151 solved)
by Dominik Schreiber

Parallel Track SAT – Results

The Top 3 solvers of the Parallel Track SAT are:

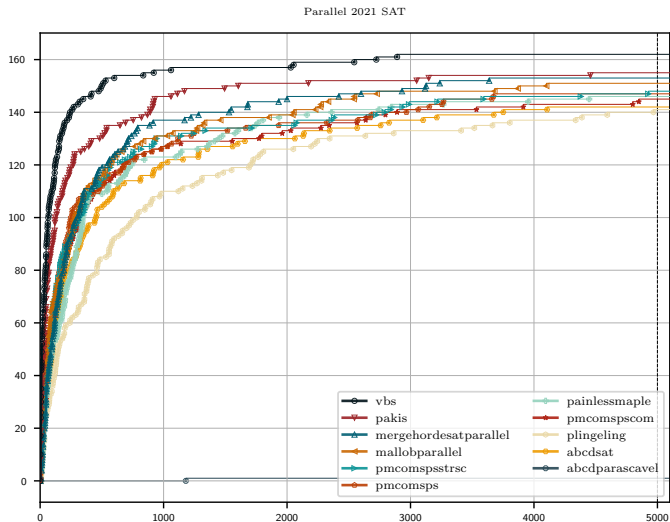
- 2 **Merge-Hordesat-Parallel** (PAR-2: 1977, 153 solved)
by Norbert Manthey
- 3 **Mallob-Parallel** (PAR-2: 2084, 151 solved)
by Dominik Schreiber

Parallel Track SAT – Results

The Top 3 solvers of the Parallel Track SAT are:

- 1 **PaKis** (PAR-2: 1758, 155 solved)
by Rodrigue Konan Tchinda and Clémentin Tayou Djamegni
- 2 **Merge-Hordesat-Parallel** (PAR-2: 1977, 153 solved)
by Norbert Manthey
- 3 **Mallob-Parallel** (PAR-2: 2084, 151 solved)
by Dominik Schreiber

Parallel Track SAT – Plot



Parallel Track UNSAT – Results

The Top 3 solvers of the Parallel Track UNSAT are:

Parallel Track UNSAT – Results

The Top 3 solvers of the Parallel Track UNSAT are:

- 3 **P-MCOMSPS-STR-32-SC** (PAR-2 1274, 164 solved)
by Zhihui Li, Guanfeng Wu, Yang Xu, and Huimin Fu

Parallel Track UNSAT – Results

The Top 3 solvers of the Parallel Track UNSAT are:

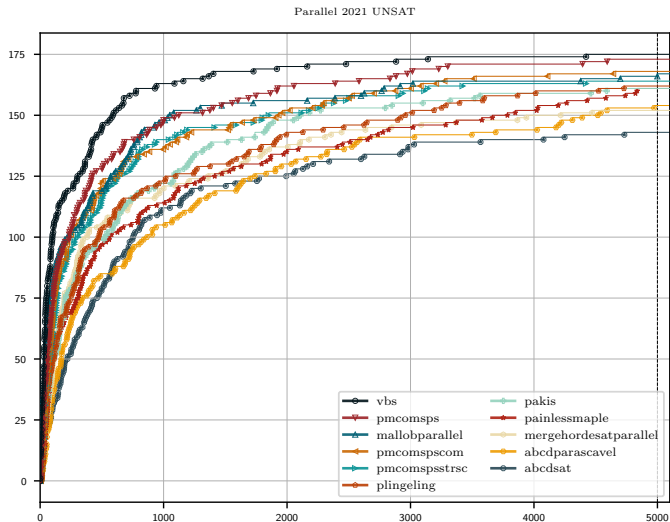
- 2 **Mallob-Parallel** (PAR-2: 1088, 167 solved)
by Dominik Schreiber
- 3 **P-MCOMSPS-STR-32-SC** (PAR-2 1274, 164 solved)
by Zhihui Li, Guanfeng Wu, Yang Xu, and Huimin Fu

Parallel Track UNSAT – Results

The Top 3 solvers of the Parallel Track UNSAT are:

- 1 **P-MCOMSPS** (PAR-2: 829, 173 solved)
by Vincent Vallade, Ludovic Le Frioux, Razvan Oanea, Souheib Baarir, Julien Sopena, Fabrice Kordon, Saeed Nejati, and Vijay Ganesh
- 2 **Mallob-Parallel** (PAR-2: 1088, 167 solved)
by Dominik Schreiber
- 3 **P-MCOMSPS-STR-32-SC** (PAR-2 1274, 164 solved)
by Zhihui Li, Guanfeng Wu, Yang Xu, and Huimin Fu

Parallel Track UNSAT – Plot



Parallel Track ALL – Results

The Top 3 solvers of the Parallel Track ALL are:

Parallel Track ALL – Results

The Top 3 solvers of the Parallel Track ALL are:

- 3 **PaKis** (PAR-2: 2465, 316 solved)
by Rodrigue Konan Tchinda and Clémentin Tayou Djamegni

Parallel Track ALL – Results

The Top 3 solvers of the Parallel Track ALL are:

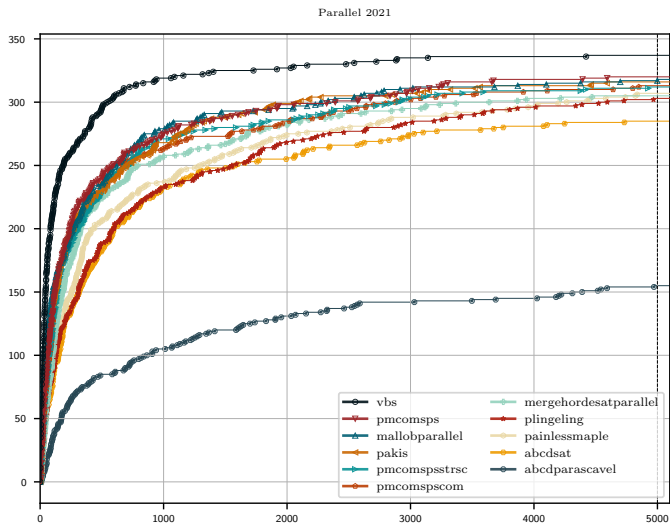
- 2 **Mallob-Parallel** (PAR-2: 2411, 318 solved)
by Dominik Schreiber
- 3 **PaKis** (PAR-2: 2465, 316 solved)
by Rodrigue Konan Tchinda and Clémentin Tayou Djamegni

Parallel Track ALL – Results

The Top 3 solvers of the Parallel Track ALL are:

- 1 **P-MCOMSPS** (PAR-2: 2386, 320 solved)
by Vincent Vallade, Ludovic Le Frioux, Razvan Oanea, Souheib Baarir, Julien Sopena, Fabrice Kordon, Saeed Nejati, and Vijay Ganesh
- 2 **Mallob-Parallel** (PAR-2: 2411, 318 solved)
by Dominik Schreiber
- 3 **PaKis** (PAR-2: 2465, 316 solved)
by Rodrigue Konan Tchinda and Clémentin Tayou Djamegni

Parallel Track ALL – Plot



Cloud Track – Results

The Top 3 solvers of the Cloud Track are:

Cloud Track – Results

The Top 3 solvers of the Cloud Track are:

- 3 **PMCOMSPS-MPI** (PAR-2: 3900, 254 solved)
by Vincent Vallade, Ludovic Le Frioux, Razvan Oanea, Souheib Baarir,
Julien Sopena, Fabrice Kordon, Saeed Nejati, and Vijay Ganesh

Cloud Track – Results

The Top 3 solvers of the Cloud Track are:

2 **Merge-Hordesat** (PAR-2: 3466, 269 solved)
by Norbert Manthey

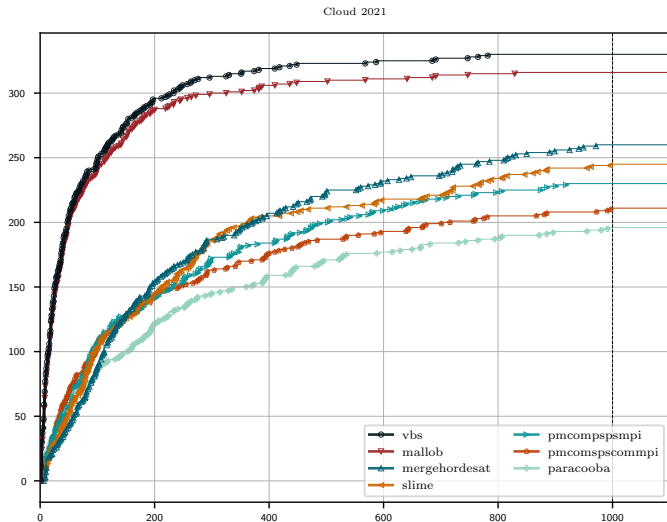
3 **PMCOMSPS-MPI** (PAR-2: 3900, 254 solved)
by Vincent Vallade, Ludovic Le Frioux, Razvan Oanea, Souheib Baarir,
Julien Sopena, Fabrice Kordon, Saeed Nejati, and Vijay Ganesh

Cloud Track – Results

The Top 3 solvers of the Cloud Track are:

- 1 **Mallob** (PAR-2: 2160, 316 solved)
by Dominik Schreiber
- 2 **Merge-Hordesat** (PAR-2: 3466, 269 solved)
by Norbert Manthey
- 3 **PMCOMSPS-MPI** (PAR-2: 3900, 254 solved)
by Vincent Vallade, Ludovic Le Frioux, Razvan Oanea, Souheib Baarir,
Julien Sopena, Fabrice Kordon, Saeed Nejati, and Vijay Ganesh

Cloud Track – Plot



Results of CaDiCaL Hack Track

Winner of CaDiCaL Hack Track

Results of CaDiCaL Hack Track

Winner of CaDiCaL Hack Track

- CaDiCaL watch_sat
- Author: Norbert Manthey
- PAR-2: 3613 (Solved: 283)

Crypto Track – Results

The Top 3 solvers of the Crypto Track are:

Crypto Track – Results

The Top 3 solvers of the Crypto Track are:

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-
- 3 **Relaxed_LCFTP_V2** (PAR-2: 4119, 125 solved)
by Shunyang Bi, Zhang Qu, Hailong You,
Meihua Liu, Pengfei Li, and Yang Zhang

Crypto Track – Results

The Top 3 solvers of the Crypto Track are:

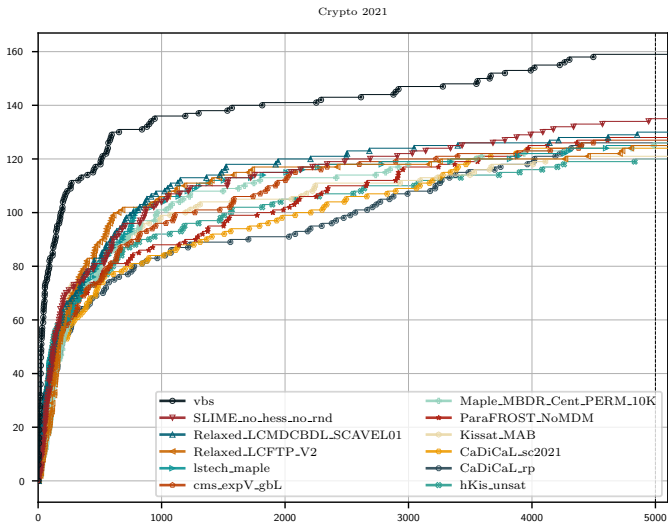
- 2 **Relaxed_LCMDCBDL_SCAVEL01** (PAR-2: 3896, 130 solved)
by Zhihui Li, Guanfeng Wu, Yang Xu, and Huimin Fu
- 3 **Relaxed_LCFTP_V2** (PAR-2: 4119, 125 solved)
by Shunyang Bi, Zhang Qu, Hailong You,
Meihua Liu, Pengfei Li, and Yang Zhang

Crypto Track – Results

The Top 3 solvers of the Crypto Track are:

- 1 **SLIME_no_hess_no_rnd** (PAR-2: 3792, 135 solved)
by Oscar Riveros
- 2 **Relaxed_LCMDCBDL_SCAVEL01** (PAR-2: 3896, 130 solved)
by Zhihui Li, Guanfeng Wu, Yang Xu, and Huimin Fu
- 3 **Relaxed_LCFTP_V2** (PAR-2: 4119, 125 solved)
by Shunyang Bi, Zhang Qu, Hailong You,
Meihua Liu, Pengfei Li, and Yang Zhang

Crypto Track – Plot



Main Track SAT – Results

The Top 3 solvers of the Main Track SAT are:

Main Track SAT – Results

The Top 3 solvers of the Main Track SAT are:

- 3 **kissat_gb** (PAR-2: 2430, 143 solved)
by Md Solimul Chowdhury, Martin Müller and Jia-Huai You

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The Top 3 solvers of the Main Track SAT are:

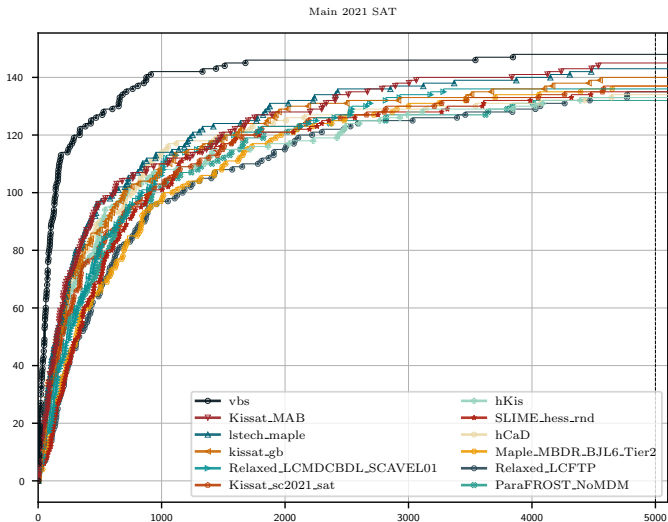
- 2 **lstech_maple** (PAR-2: 2358, 144 solved)
by Xindi Zhang, Shaowei Cai, and Zhihan Chen
- 3 **kissat_gb** (PAR-2: 2430, 143 solved)
by Md Solimul Chowdhury, Martin Müller and Jia-Huai You

Main Track SAT – Results

The Top 3 solvers of the Main Track SAT are:

- 1 **Kissat_MAB** (PAR-2: 2222, 148 solved)
by Mohamed Sami Cherif, Djamal Habet and Cyril Terrioux
- 2 **Istech_maple** (PAR-2: 2358, 144 solved)
by Xindi Zhang, Shaowei Cai, and Zhihan Chen
- 3 **kissat_gb** (PAR-2: 2430, 143 solved)
by Md Solimul Chowdhury, Martin Müller and Jia-Huai You

Main Track SAT – Top 10 Plot



Main Track UNSAT – Results

The Top 3 solvers of the Main Track UNSAT are:

Main Track UNSAT – Results

The Top 3 solvers of the Main Track UNSAT are:

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-
- 3 **Kissat_sc2021_sweep** (PAR-2: 1697, 151 solved)
by Armin Biere

Main Track UNSAT – Results

The Top 3 solvers of the Main Track UNSAT are:

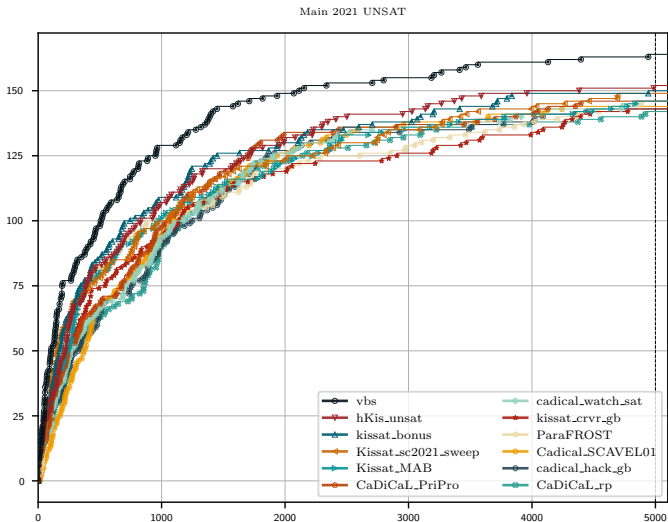
- 2 **kissat_bonus** (PAR-2: 1552, 152 solved)
by Xindi Zhang, Shaowei Cai, and Zhihan Chen
- 3 **Kissat_sc2021_sweep** (PAR-2: 1697, 151 solved)
by Armin Biere

Main Track UNSAT – Results

The Top 3 solvers of the Main Track UNSAT are:

- 1 **hKis_unsat** (PAR-2: 1543, 153 solved)
by Rodrigue Konan Tchinda and Clémentin Tayou Djamegni
- 2 **kissat_bonus** (PAR-2: 1552, 152 solved)
by Xindi Zhang, Shaowei Cai, and Zhihan Chen
- 3 **Kissat_sc2021_sweep** (PAR-2: 1697, 151 solved)
by Armin Biere

Main Track UNSAT – Top 10 Plot



Main Track ALL – Results

The Top 3 solvers of the Main Track ALL are:

Main Track ALL – Results

The Top 3 solvers of the Main Track ALL are:

- 3 **kissat_gb** (PAR-2: 3366, 289 solved)
by Md Solimul Chowdhury, Martin Müller and Jia-Huai You

Main Track ALL – Results

The Top 3 solvers of the Main Track ALL are:

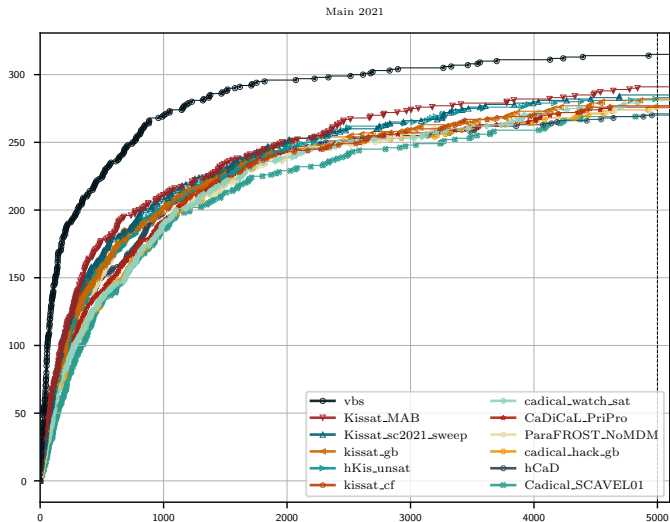
- 2 **Kissat_sc2021_sweep** (PAR-2: 3365, 288 solved)
by Armin Biere
- 3 **kissat_gb** (PAR-2: 3366, 289 solved)
by Md Solimul Chowdhury, Martin Müller and Jia-Huai You

Main Track ALL – Results

The Top 3 solvers of the Main Track ALL are:

- 1 **Kissat_MAB** (PAR-2: 3194, 296 solved)
by Mohamed Sami Cherif, Djamal Habet and Cyril Terrioux
- 2 **Kissat_sc2021_sweep** (PAR-2: 3365, 288 solved)
by Armin Biere
- 3 **kissat_gb** (PAR-2: 3366, 289 solved)
by Md Solimul Chowdhury, Martin Müller and Jia-Huai You

Main Track ALL– Top 10 Plot



Special Innovation Price

Winner of the Special Innovation Price

Special Innovation Price

Winner of the Special Innovation Price

CaDiCaL_PriPro, Benjamin Kaiser and Robert Clausecker

Special Innovation Price

Winner of the Special Innovation Price

CaDiCaL_PriPro, Benjamin Kaiser and Robert Clausecker

Best k-Portfolios by PAR-2 Score of their VBS

k	Portfolio	PAR-2
1	{Kissat_MAB}	3194
2	{ CaDiCaL_PriPro , Istech_maple}	2679
3	{ CaDiCaL_PriPro , Istech_maple, Kissat_sc2021_sweep}	2471
4	{Kissat_sc2021_sweep, Istech_maple, hKis, hCaD_psid}	2374
...		
n	VBS	2152

Honorable Mentions I

Crypto (NoLimits)

Maple_MBDR_BJL6_Tier2 by Sima Jamali and David Mitchell

- No Award to failing proofs
- PAR-2 Score of 3830 in NoLimits Evaluation (Second Place)

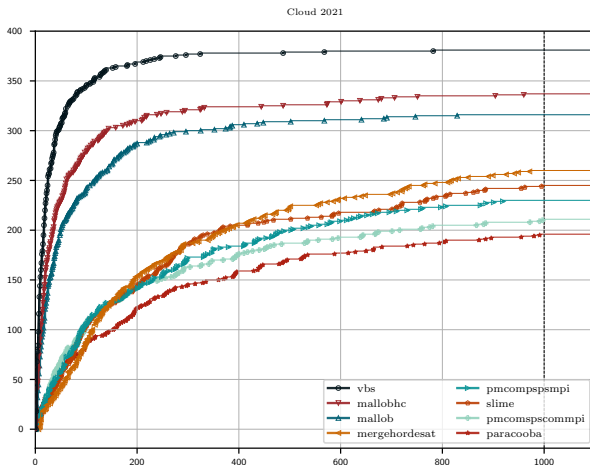
Crypto (Cadical Hack)

CaDiCaL_rp by Xindi Zhang, Shaowei Cai, and Zhihan Chen

- PAR-2 Score of 4390 in Crypto Track (Best Hack)

Honorable Mentions II

- **Mallob HC** (PAR-2: 1633, 337 solved) by Dominik Schreiber
- Winner: **Mallob** (PAR-2: 2160, 316 solved)



More information and Acknowledgments

Additional Information

- The Competition Proceedings (solver and benchmark descriptions) will soon be available at <https://satcompetition.github.io/2021/>
- For the detailed competition results see the SAT Competition website

Acknowledgments

- Thanks to all the participants
- Thanks for all the benchmarks
- Thanks to Mike Whalen, Jonathan Eidelman, and Frankie Botero at AWS
- Thanks to Aaron Stump and StarExec
- Thanks to CAS Software Karlsruhe for the medals
- Thank You for Your attention