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

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 UKNOWN
- 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

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

- **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

- **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

- 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:

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
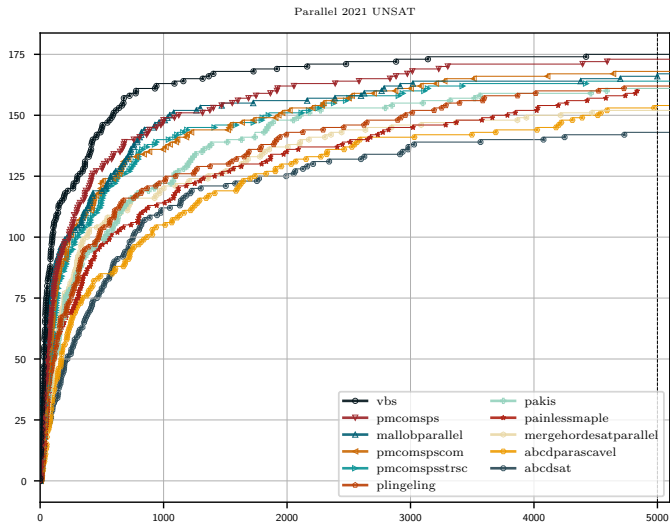
Parallel Track SAT – Plot

Parallel 2021 SAT
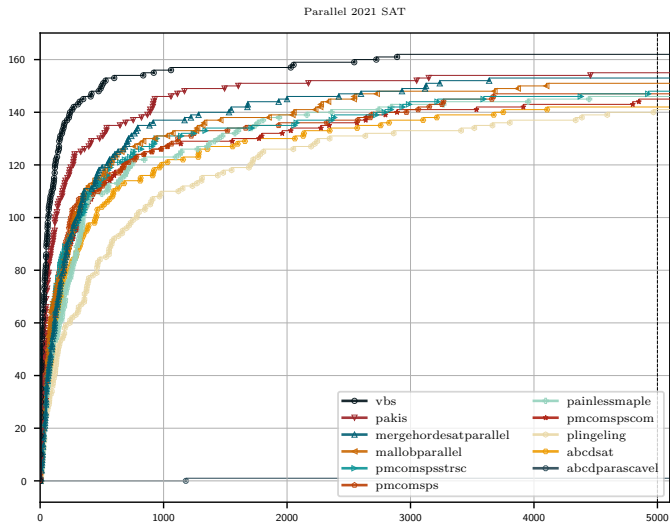
Parallel Track UNSAT – Results

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 2021 UNSAT

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

Parallel 2021
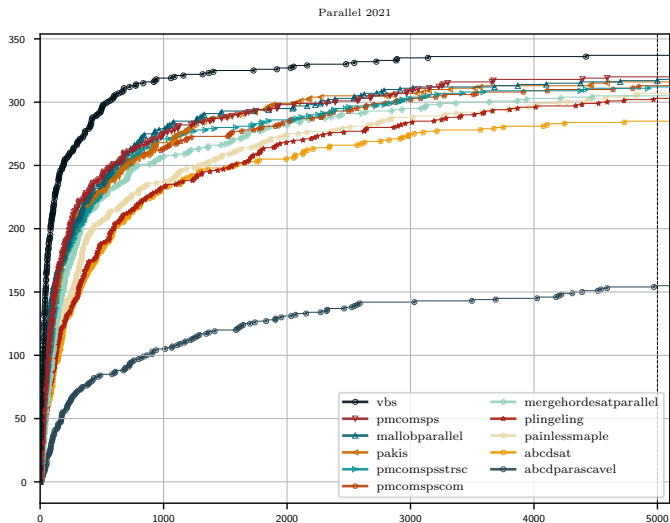
Cloud Track – Results

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

Cloud 2021
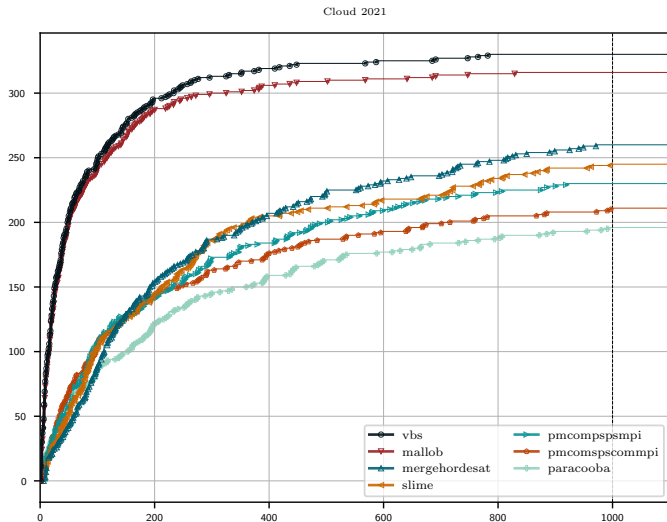
Results of CaDiCaL Hack Track
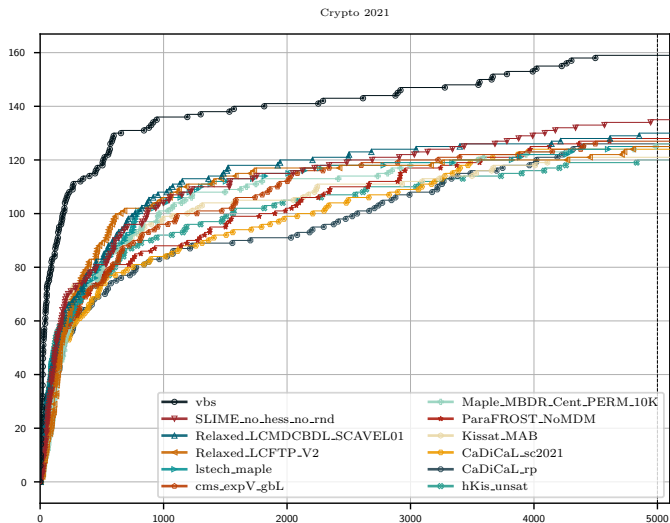
Winner of CaDiCaL Hack Track

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

Crypto Track – Results

The Top 3 solvers of the Crypto Track are:

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

Crypto 2021

Legend:
- vbs
- SLIME_no_hess_no_rnd
- Relaxed_LCMDCBDL_SCAVEL01
- Relaxed_LCFTP_V2
- lstech_maple
- cms_expV_gbL
- Maple_MBDR_Cent_PERM_10K
- ParaFROST_NoMDM
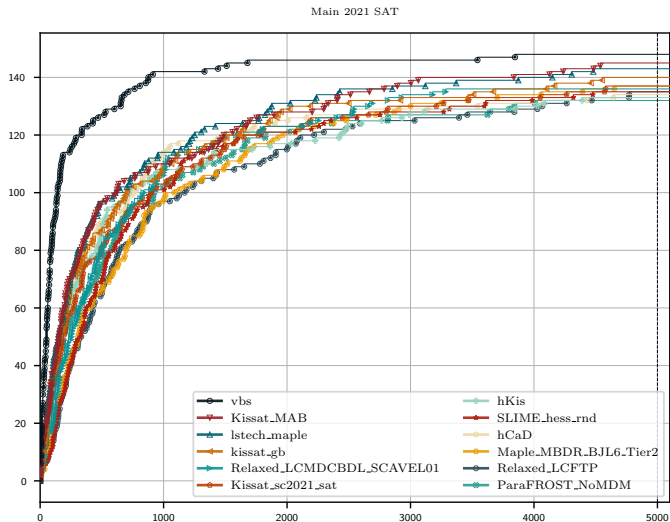- Kissat_MAB
- CaDiCaL_sc2021
- CaDiCaL_rp
- hKis_unsat

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. **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 – Top 10 Plot

Main 2021 SAT

Legend:
- vbs
- Kissat_MAB
- lstech_maple
- kissat_gb
- Relaxed_LCMDCBDL_SCAVEL01
- Kissat_sc2021_sat
- hKis
- SLIME_hess_rnd
- hCaD
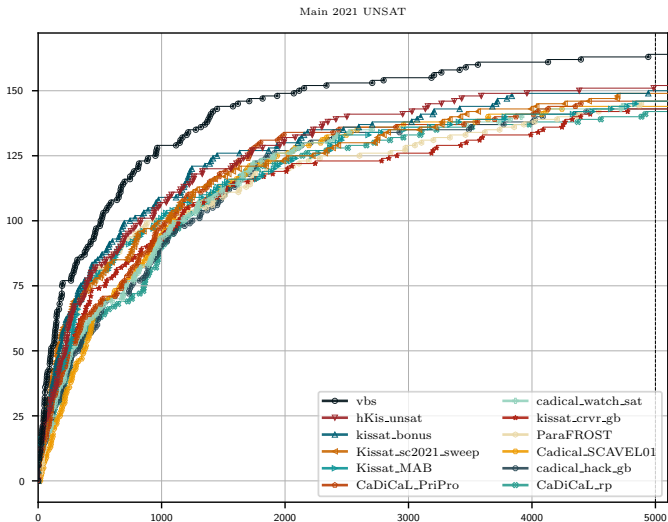- Maple_MBDR_BJL6_Tier2
- Relaxed_LCFTP
- ParaFROST_NoMDM

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)
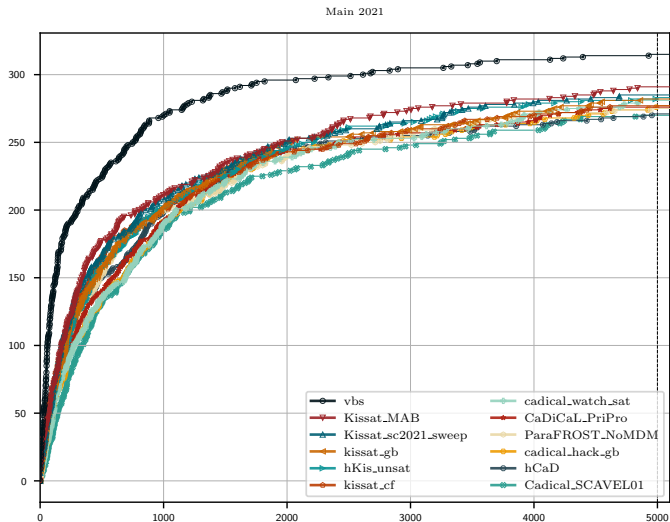   by Armin Biere

Main 2021 UNSAT

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

Main 2021

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**, lstech_maple}	2679
3	{**CaDiCaL_PriPro**, lstech_maple, Kissat_sc2021_sweep}	2471
4	{Kissat_sc2021_sweep, lstech_maple, hKis, hCaD_psids}	2374
	. . .	
n	VBS	2152

Honorable Mentions I

Crypto (NoLimits)

Maple_MBDR_BJL6_Tier2 by Sima Jamali and David Mitchell

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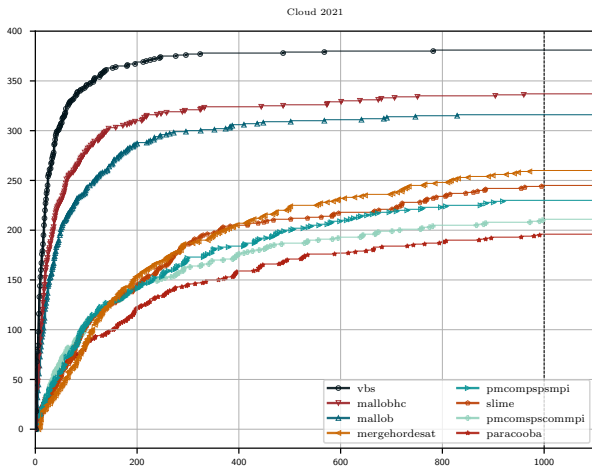- PAR-2 Score of 3830 in NoLimits Evaluation (Second Place)

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)

Cloud 2021

More information and Acknowledgments

Additionals 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

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- Thank You for Your attention