FLoC Olympic Games 2014

Citius, Maius, Potentius — Faster, Bigger, More Powerful

Anton Belov — Synopsys
Daniel Diepold — eXXcellent solutions
Marijn Heule — The University of Texas at Austin
Matti Järvisalo — University of Helsinki

Pete Manolios
Lakhdar Saïs
Peter Stuckey

SAT Competition 2014

Ninth International SAT Competition

- The International SAT Competitions have been contributing to the impressive performance boost of SAT solvers since 2002
  - A relatively objective testbed for the practical importance of novel search techniques

- Highlights from the SAT Competition 2014
  - High participation: 79 participants and 137 submitted solvers
  - Many resources: 5.000 (s) timeout, in total 400.000 CPU hours
  - Validation of results: witness for SAT and proof for UNSAT

- Three categories for both sequential and parallel solvers
  - Application category with benchmarks from industry
  - Hard-combinatorial category with benchmarks to obstruct solvers
  - Random category with scientifically interesting benchmarks

SAT Competition 2014: Tracks

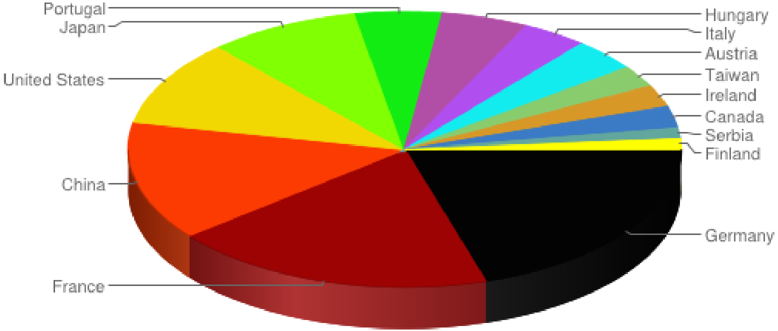
1. Sequential, Application SAT
2. Sequential, Application certified UNSAT
3. Sequential, Application SAT+UNSAT
4. Sequential, Hard-combinatorial SAT
5. Sequential, Hard-combinatorial certified UNSAT
6. Sequential, Hard-combinatorial SAT+UNSAT
7. Sequential, Random SAT
8. Parallel, Hard-combinatorial SAT+UNSAT
9. Parallel, Application SAT+UNSAT
10. Parallel, Random SAT *new*
11. Sequential, MiniSAT Hack, Application SAT+UNSAT

SAT Competition 2014: Rules (excerpt)

1. The source code of submitted SAT solvers must be made available;
2. Full source code submissions only (no libraries);
3. Each (co-)author was limited to four sequential solvers, two parallel solvers and one MiniSAT hack track submission;
4. At most two different SAT solving engines for all runs per solver;
5. Every solver and benchmark submission needs to be accompanied with a short solver / benchmark description;
6. A wrong answer will disqualify a solver for all tracks it participates in;
7. Solvers cannot be withdrawn after the submission deadline.

SAT Competition 2014: Participation

- We had 137 solver submissions of which 70 participated
- We had 79 participants from 14 countries

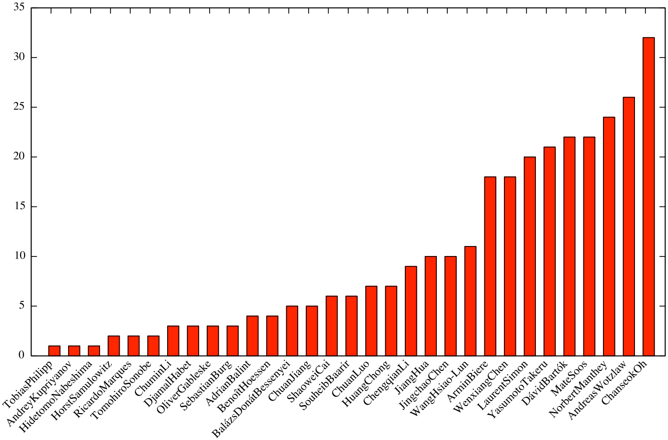


SAT Competition 2014: Certified UNSAT

- Proofs were mandatory in UNSAT tracks as during SC 2013
- New checker *DRAT-trim* is able to validate all SAT techniques
- Example validation of proof by cryptominisat-4.1-st while solving q_query_3_l48_lambda.cnf using 126.26 (s) CPU time:

```
c reading proof from stdin
c finished parsing
c detected empty clause; start verification via backward checking
c 34958 of 174528 clauses in core
c 668933 of 1332081 lemmas in core using 30685879 resolution steps
c 2766 RAT lemmas in core; 481098 redundant literals in core lemmas
Verification took 177 seconds. Checker output: s VERIFIED
```

SAT Competition 2014: Code Statistics



Number of times a user has submitted code in EDACC.

- 313 code submissions for 137 solvers $\rightarrow$ 2.3 submissions per solver

SAT Competition 2014: Execution

- One phase competition
- Automatized testing phase for competitors to test their solvers
- No further changes possible after the testing phase
- Texas Advanced Computing Center (TACC)
  - 2 Hex-core Xeon 5680 processors, 3.33 GHz with 24GB RAM per node
  - Used $\sim$90.000h of CPU time on 12 core nodes (wasting 5/6 CPU time)
  - Blocked $\sim$400.000h of CPU time of resources
- Execution System: EDACC
  - Simple and transparent execution of solvers on distributed clusters
  - Automatic collection and (statistical) analysis of the results
  - Web front end provides a competition mode (with user management)

SAT Competition 2014: Proceedings

- Includes all submitted solver and benchmark descriptions
- Descriptions of benchmark selection and generation procedures
- Permanent URL:
  `http://hdl.handle.net/10138/135571`
- ISBN 978-951-51-0043-6
- Solver description and sources for each solver also available through the EDACC web front-end

SAT Competition 2014: Benchmarks

Application and Hard-Combinatorial tracks

- Submissions: 7 Application, 7 Hard-Combinatorial.
- 50% of selected Application and 50% of selected Hard-Combinatorial benchmarks are new.
- Large diversity: 23 sources (“buckets”) in Application; 29 in Hard-Combinatorial.

Random tracks

- SAT benchmarks: k-SAT for $k \in \{3, 4, 5, 6, 7\}$
  - “Threshold” – around the threshold, up to 13.000 vars.
  - “Huge” – under threshold, up to 1.000.000 vars.
- No UNSAT benchmarks due to lack of competitive solvers

SAT Competition 2014: MiniSAT Hack Track

MiniSAT Hack Track

1. 222; MiniSat_HACK_999ED; Chanseok Oh
2. 213; minisat_blbd; Jingchao Chen
3. 191; ROKKminisat; Takeru Yasumoto

SAT Competition 2014: Parallel Structured Tracks

Parallel Application SAT + UNSAT

1. 277; Plingeling; Armin Biere
2. 248; PeneLoPe; Gilles Audemard, Benoît Hoessen, Saïd Jabbour, Jean-Marie Lagniez, and Cédric Piette
3. 248; Treengeling, Armin Biere

Parallel Hard-Combinatorial SAT + UNSAT

1. 227; Treengeling; Armin Biere
2. 221; Plingeling; Armin Biere
3. 205; Ricardo Marques, Luís Guerra e Silva, Paulo Flores and Luś Miguel Silveira

SAT Competition 2014: Random Satisfiable Benchmarks

Sequential Random SAT

1. 115; dimentheus; Oliver Gableske
2. 101; BalancedZ, Chong Huang, Chumin Li, and Ruchu Xu
3. 98; CSCCSat2014; Chuan Luo, Shaowei Cai, Wei Wu, and Kaile Su

Parallel Random SAT

1. 108; pprobSAT; Adrian Balint and Uwe Schöning
2. 106; Plingeling; Armin Biere
3. 95; CSCCSat2014; Chuan Luo, Shaowei Cai, Wei Wu, and Kaile Su

SAT Competition 2014: Structured Satisfiable Benchmarks

Sequential Application SAT

1. 109; minisat_blbd; Jingchao Chen
2. 107; Riss BlackBox; Enrique Matos Alfonso and Norbert Manthey
3. 106; SWDiA5BY; Chanseok Oh

Sequential Hard-combinatorial SAT

1. 107; SparrowToRiss; Adrian Balint and Norbert Manthey
2. 106; CCAnr+glucose; Shaowei Cai, Chuan Luo, and Kaile Su
3. 104; SGSeq; Chumin Li, Hua Jiang, and Ruchu Xu

SAT Competition 2014: Structured Unsatisfiable Benchmarks

Sequential Application Certified UNSAT

1. 130; Lingeling (druplig); Armin Biere
2. 123; glucose; Gilles Audemard and Laurent Simon
3. 121; SWDiA5BY; Chanseok Oh

Sequential Hard-combinatorial Certified UNSAT

1. 105; Riss BlackBox; Enrique Matos Alfonso and Norbert Manthey
2. 96; Lingeling (druplig); Armin Biere
3. 92; glucose; Gilles Audemard and Laurent Simon

SAT Competition 2014: Structured All Benchmarks

Sequential Application SAT + UNSAT

1. 231; Lingeling; Armin Biere
2. 228; SWDiA5BY; Chanseok Oh
3. 226; Riss BlackBox; Enrique Matos Alfonso and Norbert Manthey

Sequential Hard-Combinatorial SAT + UNSAT

1. 208; glueSplit_clasp; Jingchao Chen
2. 207; Lingeling; Armin Biere
3. 206; SparrowToRiss; Adrian Balint and Norbert Manthey

SAT Competition 2014: Contribution Award Introduction

Why are certain powerful techniques not mainstream?

- Inprocessing
- Symmetry breaking
- Cutting planes

Possible answers:

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B. It is hard to find heuristics that improve overall performance
C. Implementing these techniques is very difficult

SAT Competition 2014: Contribution Award Introduction

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- Symmetry breaking
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B. It is hard to find heuristics that improve overall performance
C. Implementing these techniques is very difficult
D. These techniques are not part of MiniSAT 2.2

FLoC Olympic Games 2014

SAT Competition 2014: Contribution Award

Niklas Eén

Niklas Sörensson

In acknowledgement of their impact on SAT research through the introduction of the highly-influential MiniSAT SAT solver.

SAT Competition 2014: Thanks!

Thanks to all the submitters of benchmarks and solvers!

- All results are available on the EDACC system: `http://satcompetition.org`
- Solver and benchmark descriptions in the proceedings: `http://hdl.handle.net/10138/135571`