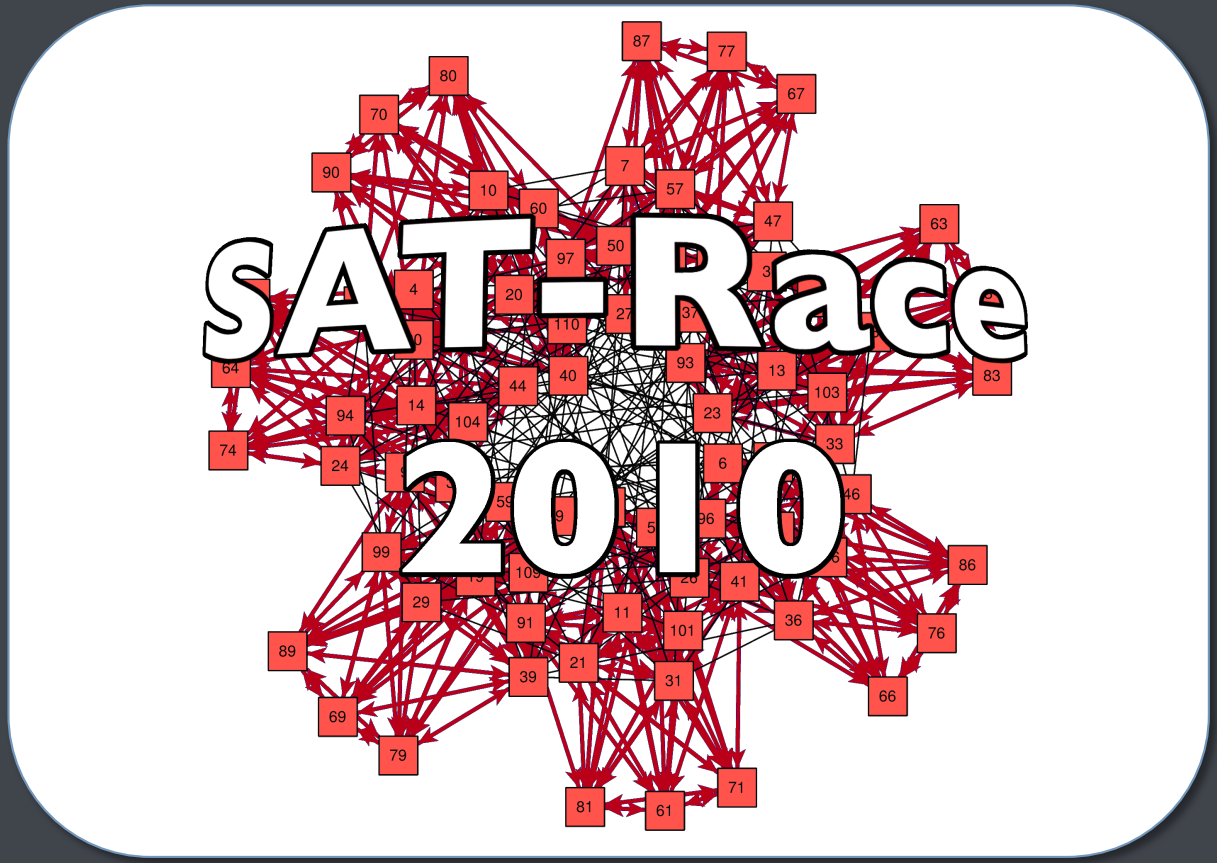


Carsten Sinz • Aarti Gupta • Youssef Hamadi
Himanshu Jain • Daniel Le Berre
Panagiotis Manolios • Yakov Novikov • Florian Merz

July 14, 2010

FLoC/SAT'10 – Edinburgh, Scotland, UK

Karlsruhe Institute of Technology

What is SAT-Race?

- Competition for sequential/parallel SAT solvers
  - Only industrial/application category benchmarks
    (no handcrafted or random)
  - Short run-times
    (15 minutes timeout per instance)
  - Mixture of satisfiable / unsatisfiable instances
    (thus not suitable for local-search solvers)
  - „Black-box“ solvers permitted
  - 3 tracks:
    - Main Track: Sequential CNF
    - Special Track 1: Parallel CNF
    - Special Track 2: Sequential AIG

Organizers

- Chair
  - **Carsten Sinz** (Karlsruhe Institute of Technology, Germany)
- Advisory Panel
  - **Aarti Gupta** (NEC Labs America, USA)
  - **Youssef Hamadi** (Microsoft Research, UK)
  - **Himanshu Jain** (Synopsys, USA)
  - **Daniel Le Berre** (Université d'Artois, France)
  - **Panagiotis Manolios** (Northeastern University, USA)
  - **Yakov Novikov** (OneSpin Solutions, Germany)
- Technical Management
  - **Florian Merz** (Karlsruhe Institute of Technology, Germany)

Entrants

- Received 32 solvers by 23 submitters from 9 nations
  - SAT-Race 2008: 43 solvers by 36 submitters from 16 nations
  - SAT-Race 2006: 29 solvers by 23 submitters from 13 nations

Australia	1
Austria	4
China	1
France	7
France / UK	4

Germany	4
Iran	1
Spain	1
Sweden	4
USA	5

- 2 industrial solvers, 27 academic, 3 mixed
- 21 solvers in Main Track, 8 in Parallel Track, 3 in AIG Track

Qualification

- To ascertain solver correctness and efficiency
- One qualification round
  - 100 benchmark instances (SAT-Race 2008)
  - Successful participation required to participate in finals
- Qualification round took place in May

Results Qualification Round

- Main Track
  - 19 solvers qualified (out of 21) by solving at least 70 out of 100 instances (no solver produced errors)
  - 2 solvers produced wrong results during finals
- Parallel Track
  - 6 solvers qualified (out of 8) by solving at least 70 out of 100 instances (1 solver had produced wrong results and was withdrawn)
  - 1 solver produced wrong results during finals
- AIG Track:
  - All 3 solvers qualified by solving more than 50 out of 100 instances
- Overall result: 28 (out of 32) solvers participated in finals
  - 17 in Main Track (plus 3 parallel solvers running in sequential mode), 5 in Parallel Track, 3 in AIG Track
  - One solver withdrawn, 3 solvers with wrong results during finals

Solvers Participating in Finals: Main Track

Solver	Affiliation
Barcelogic	TU Catalonia, Spain
borg-sat	U Texas, USA
CircleSAT	Donghua U, China
CryptoMiniSat	INRIA, France
glucose	CRIL, France
glucosER	CRIL-CNRS, France
lingeling	JKU Linz, Austria
LySAT	INRIA-Microsoft JC, France
MiniSat	Sörensson R&D, Sweden

Solver	Affiliation
oprailleur	CRIL-CNRS, France
PicoSAT	JKU Linz, Austria
PrecoSAT	JKU Linz, Austria
riss	TU Dresden, Germany
rcl	CRIL-CNRS, France
SApperloT	U Tübingen, Germany
SAT-Power	U Isfahan, Iran
SATHYS	CRIL-CNRS, France

red: new solvers

Solvers Participating in Finals: Special Tracks

Parallel Track:

Solver	Affiliation
antom	U Freiburg, Germany
ManySAT 1.1	INRIA-Microsoft JC, France
ManySAT 1.5	INRIA-Microsoft JC, France
plingeling	JKU Linz, Austria
SArTagnan	U Tübingen, Germany

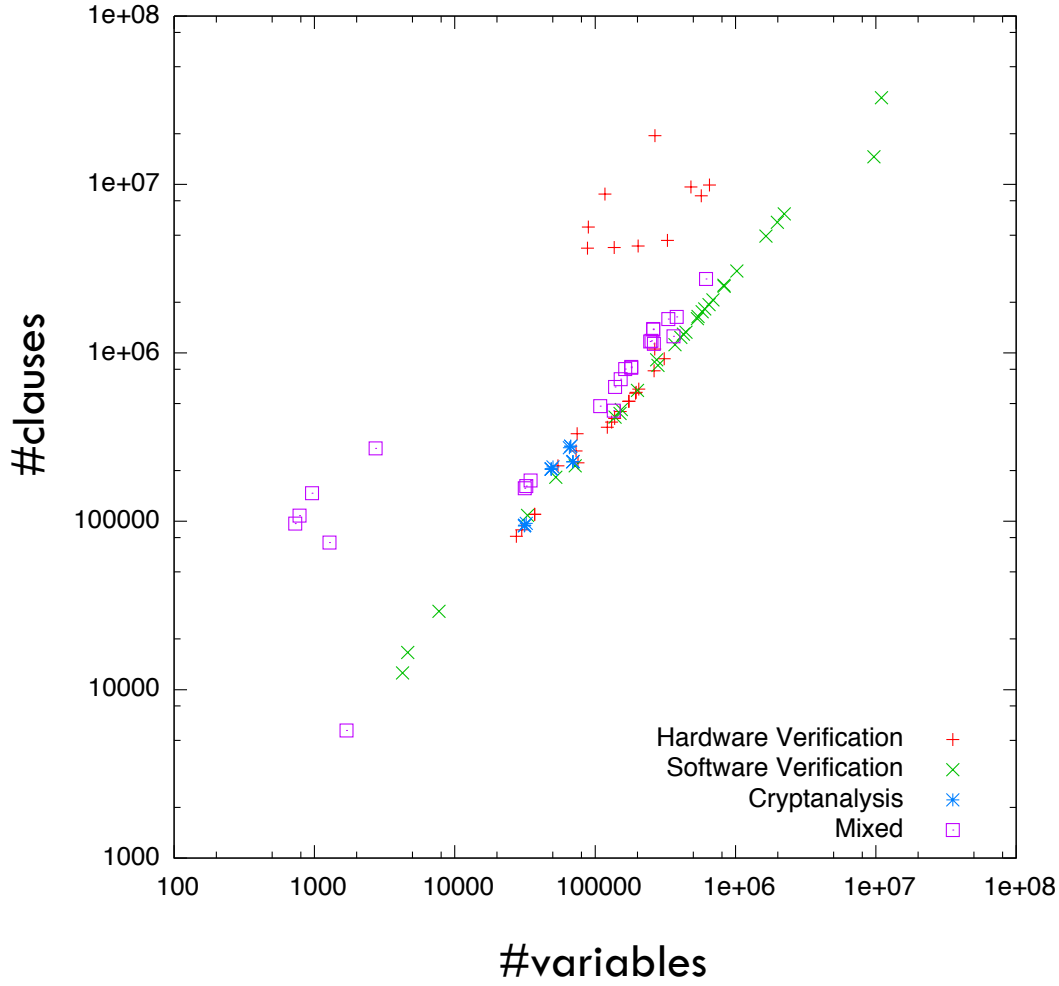
AIG Track:

Solver	Affiliation
kw_aig	Oepir, Sweden
MiniSat++	Sörensson R&D, Sweden
NFLSAT	CMU, USA

Benchmark Instances: CNF

- Corpus of 490 instances
  - Hardware verification / software verification / cryptography / mixed
  - Mainly from former SAT Competitions/Races
  - Additional software verification instances from NEC
- Selected 100 instances randomly
  - 30 hardware verification (IBM, Velev, Manolios)
  - 30 software verification (Babic, Bitverif, Fuhs, NEC, Post)
  - 15 cryptography (desgen, md5gen, Mironov-Zhang)
  - 25 mixed (Anbulagan, Bioinformatics, Diagnosis, …)
- Up to 10,950,109 variables, 32,697,150 clauses
- Smallest instance: 1694 variables, 5726 clauses

Sizes of CNF Benchmark Instances



Benchmark Instances: AIG

- Corpus of 538 instances
  - 9 Groups of Benchmark Sets (Anbulagan / Babic / c32sat / Mironov-Zhang / IBM / Intel / Manolios / Palacios / Mixed)
- Selected 100 instances randomly

Parallel Track: Special Rules

- Solver can use all 8 cores of a machine (2x Intel Xeon Quad-Core)
- Measured wall-clock time instead of CPU usage time
- Run-times for multi-threaded solvers can have high deviations (especially for satisfiable instances)
  - 3 runs for each solver on each instance
  - Instance considered solved, if solved in **first run** (SAT-Race 2008: at least 1 out of 3 runs)

Scoring

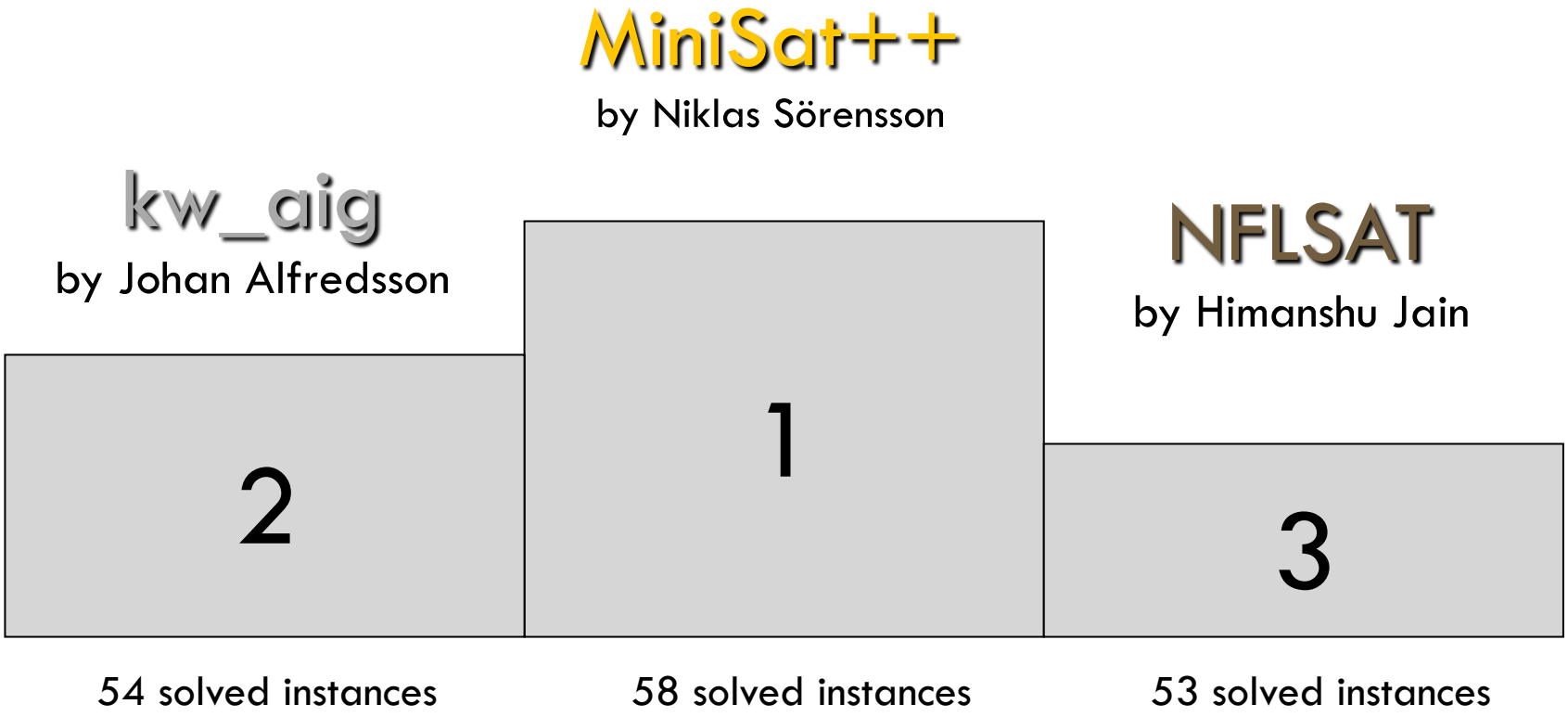
- Main criterion: number of solved instances
- Average run-time on solved instances to break ties

Computing Environment

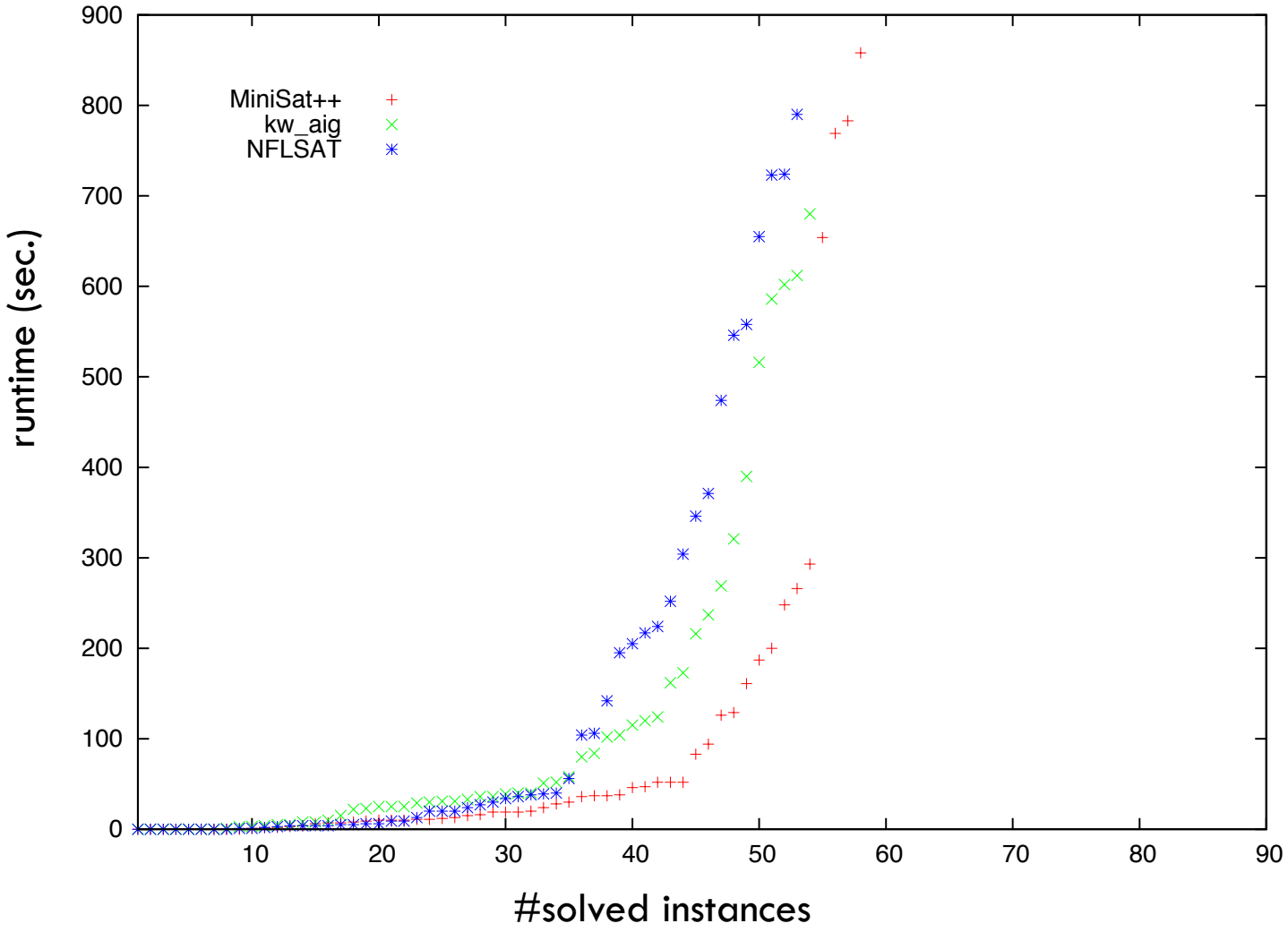
- Linux-Cluster at Karlsruhe Institute of Technology (KIT)
  - 20 compute nodes
  - 2 Intel Xeon E5430 Processors (Quad-Core, 2.66 GHz) per node
  - 32 GB of main memory per node
  - Both 32-bit and 64-bit binaries supported
- Sequential/AIG Track: only one core per solver
- Parallel Track: 8 cores per solver

Results

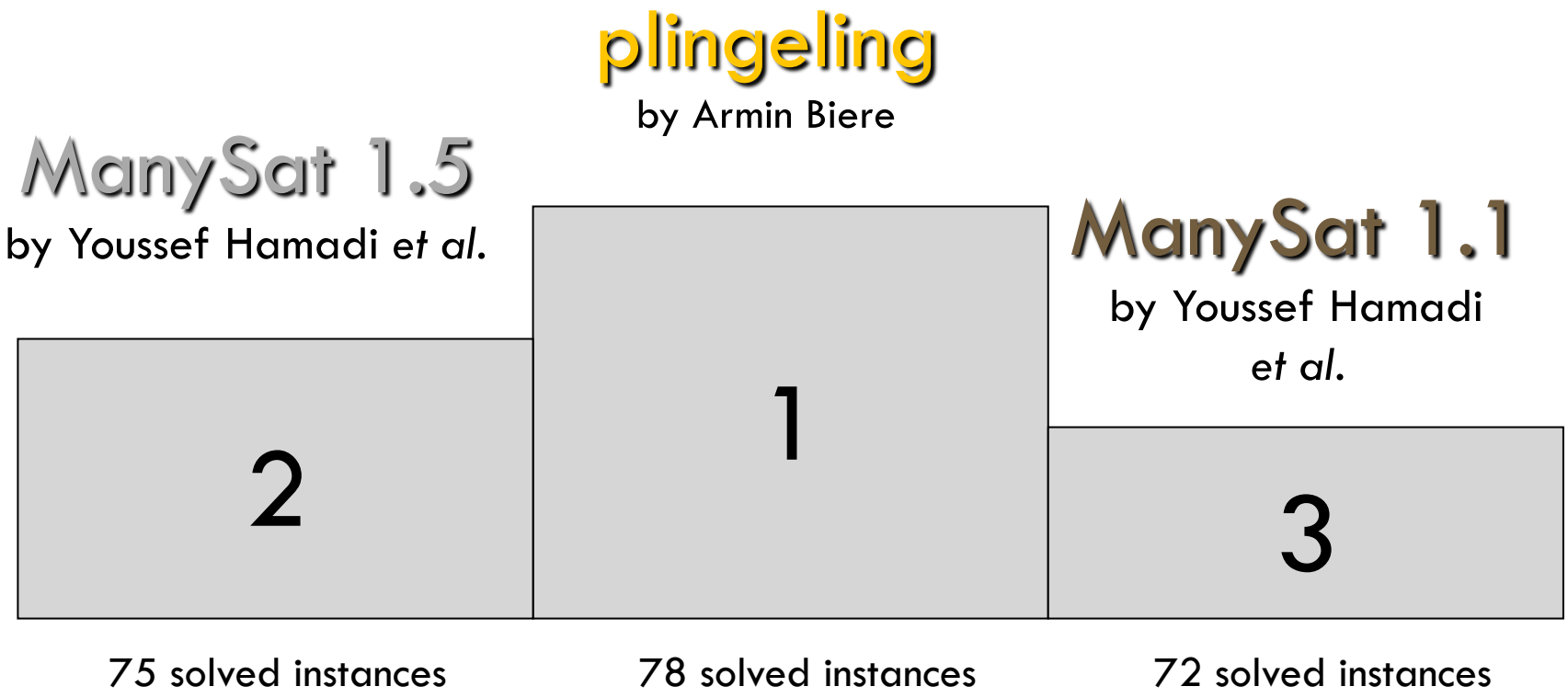
Special Track 2 (AIG Sequential)



Runtime Comparison: AIG Track

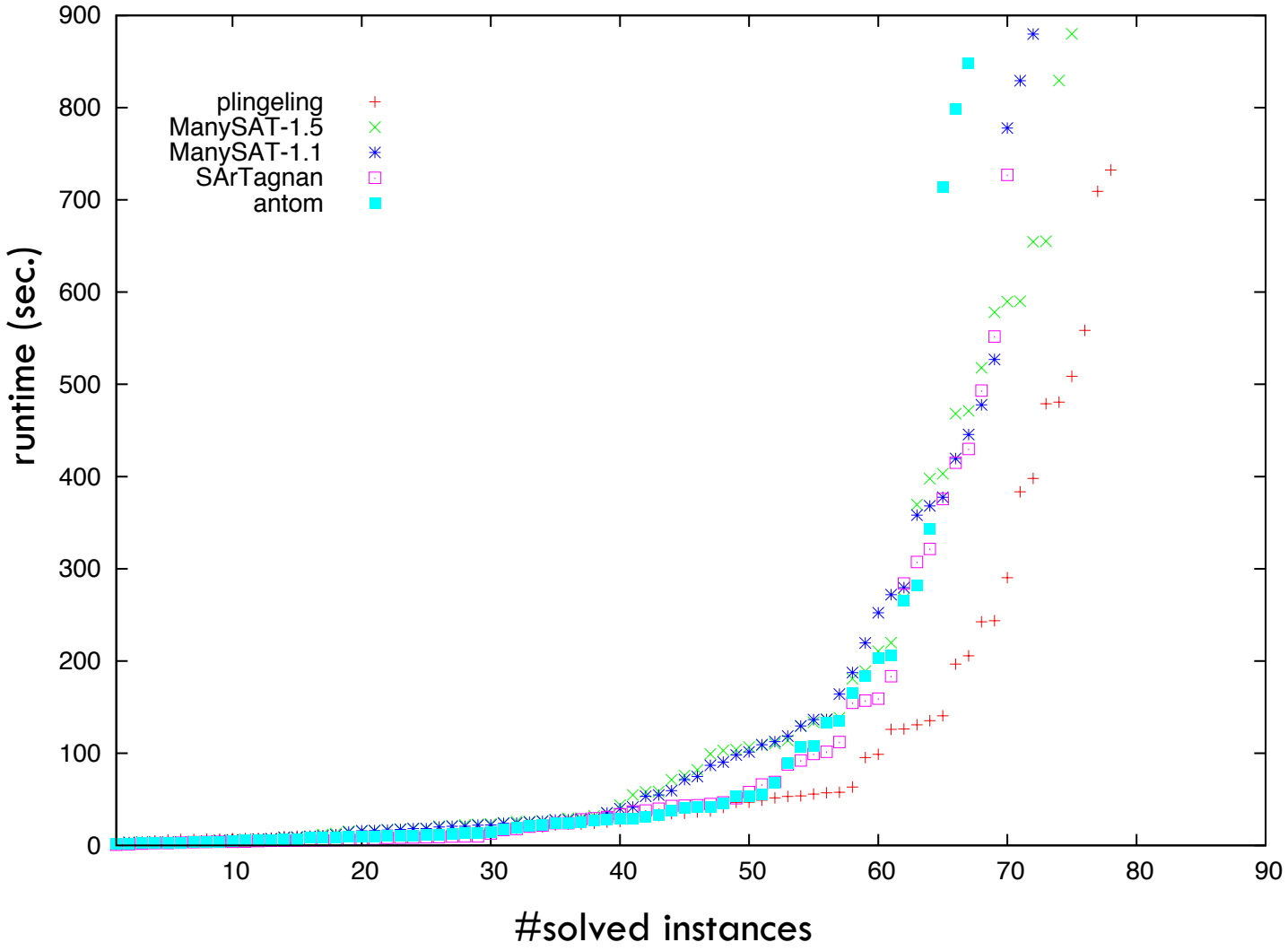


Special Track 1 (CNF Parallel)

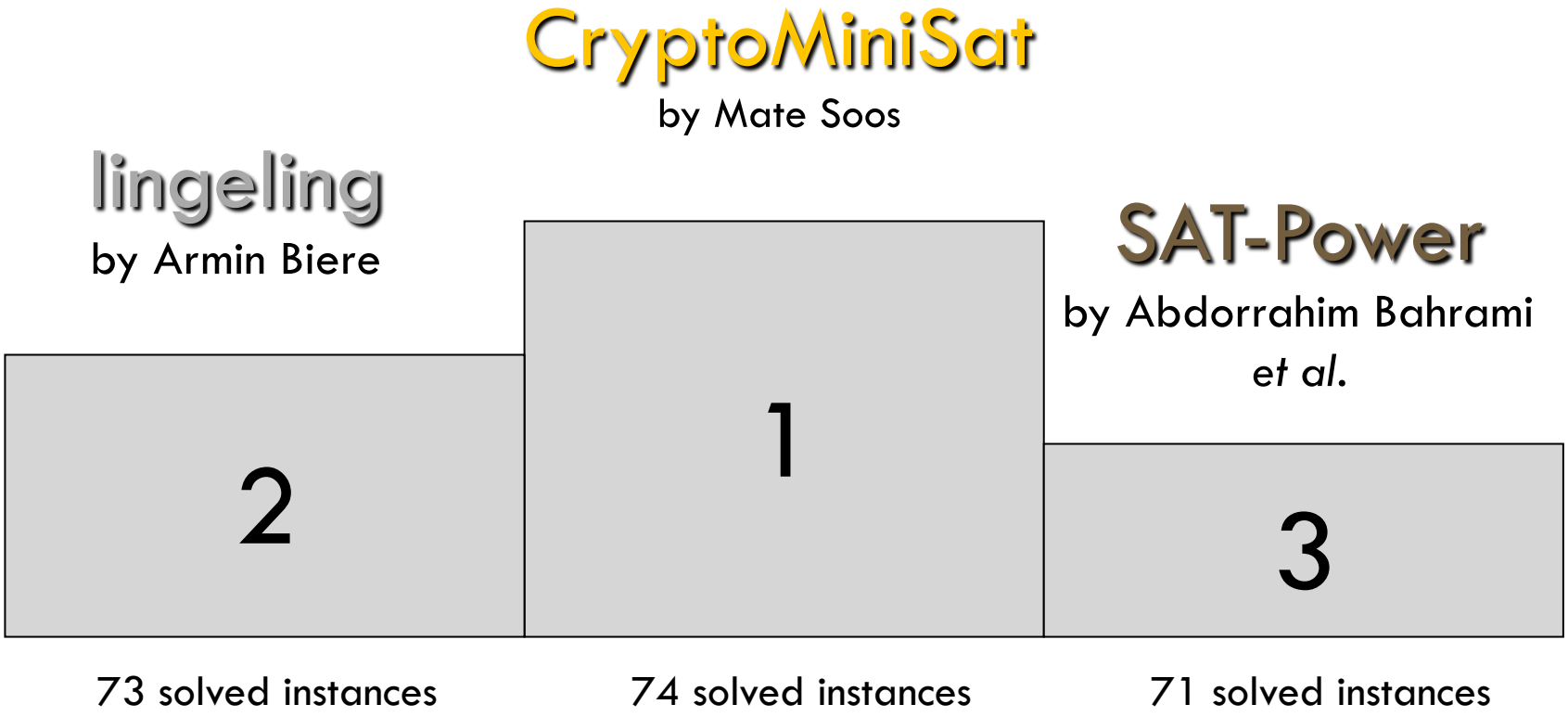


next best solver: 70 solved

Runtime Comparison: Parallel Track

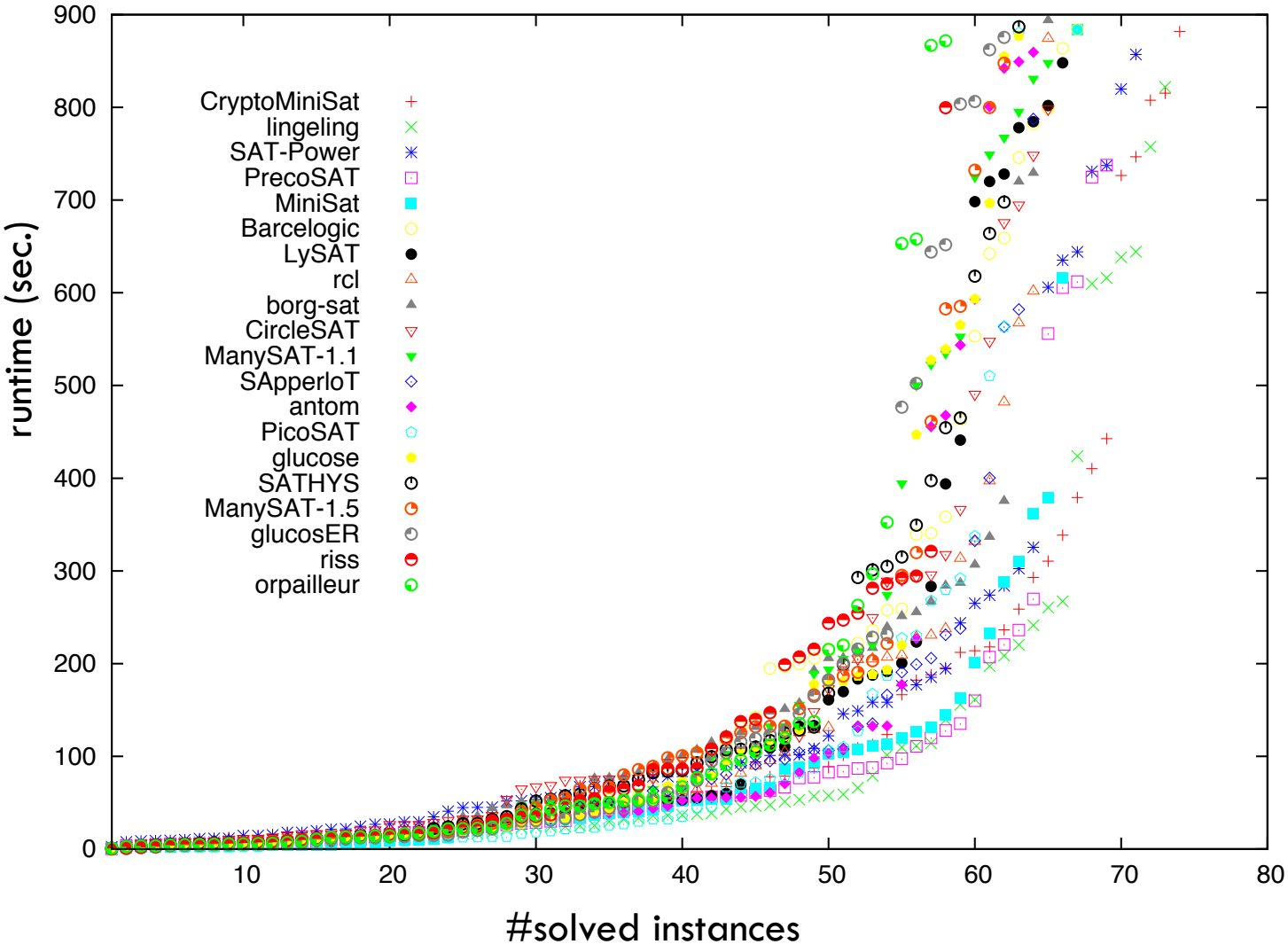


Main Track (CNF Sequential)

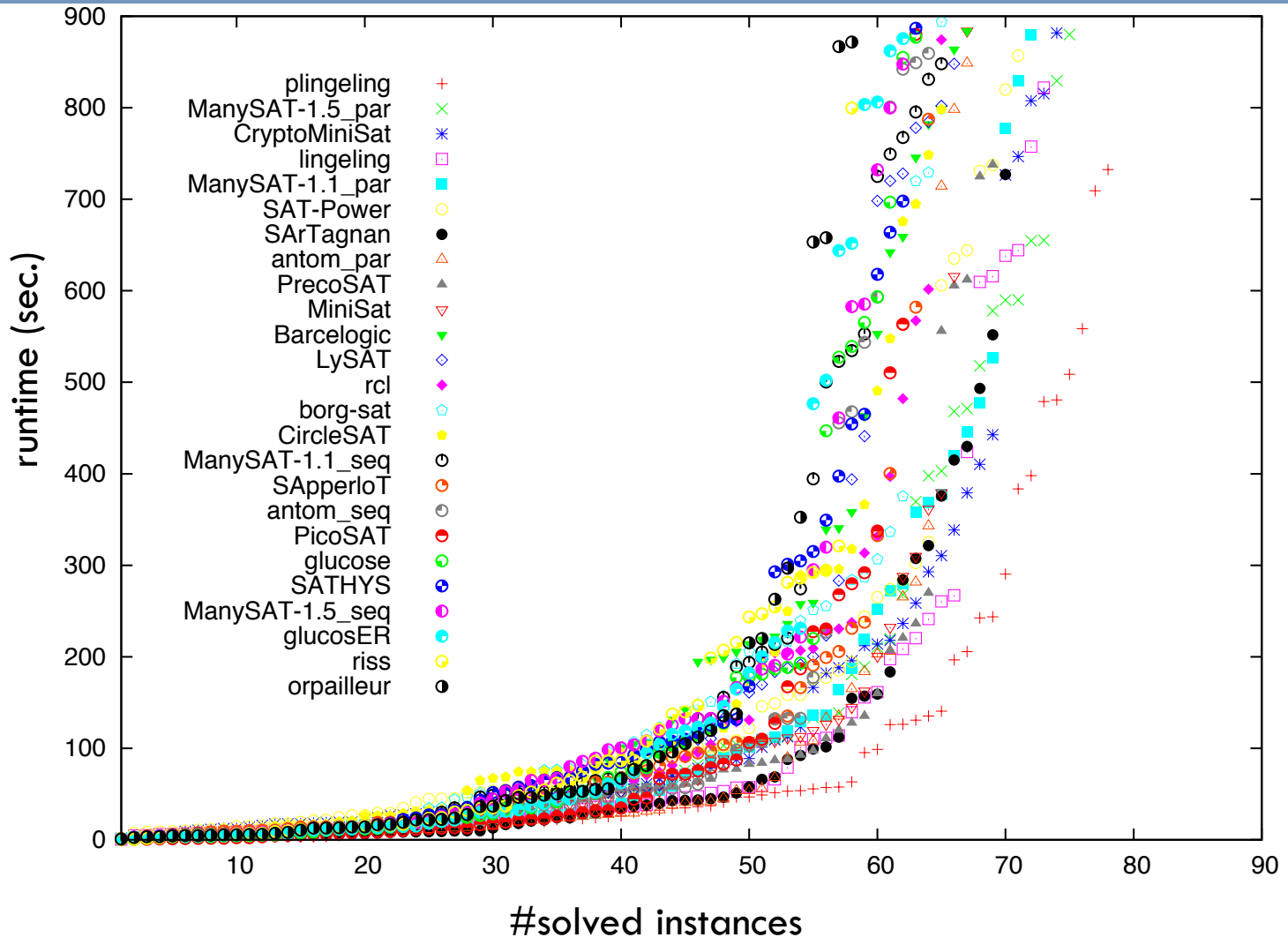


next best solver: 69 solved

Runtime Comparison: Main Track



Runtime Comparison: CNF Seq.+Par.



Student Prize

- Special prize for a solver submitted by a (team of) (PhD) student(s)
- Two prizes:
  - Main Track: **SAT-Power by Abdorrahim Bahrami** (3^{rd} place in Main Track)
  - Parallel Track: **SArTagnan by Stephan Kottler** (4^{th} place in Parallel Track)

Conclusion

- Any Progress compared to SAT-Competition 2009?
  - SAT-Race 2010 winner can solve 5 more instances than SAT-Competition 2009 winner (SAT+UNSAT Application Category) on our benchmark set
  - 3 solvers (plus 4 parallel solvers) outperform SAT-Competition 2009 winner
- Parallel solvers gain importance; improved robustness (only small differences on 3 runs)
- Many new solvers and participants

SAT-Race 2010 on the Web:
http://baldur.iti.kit.edu/sat-race-2010