FLoC Olympic Games 2014

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

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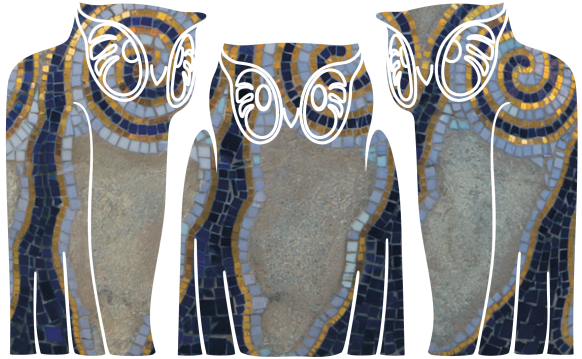
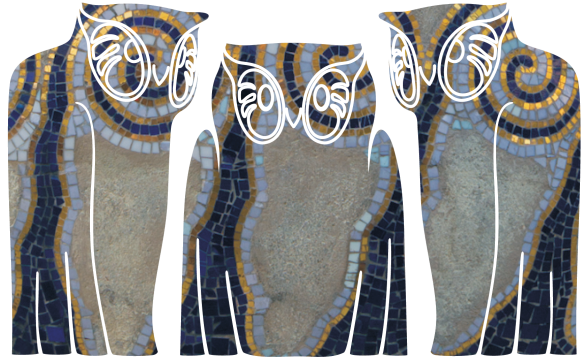
Hardware Model Checking Competition 2014 CAV Edition





History

2006	2007	2008	2010	2011	2012	2013	**2014**
AIGER format AVM'06 Ascona	1st HWMCC CAV'07 Berlin	2nd HWMCC CAV'08 Princeton	3rd HWMCC CAV'10 FLOC'10 Edinburgh	4th HWMCC FMCAD'11 Austin	5th HWMCC FMCAD'12 Cambridge UK	6th HWMCC FMCAD'13 Portland USA	**7th** **HWMCC** **CAV'14** **FLOC'14 / VSL'14** **Vienna**
Founding Lunch CAV'06 FLOC'06 Seattle		HWMCC Lunch FMCAD'08 Portland					

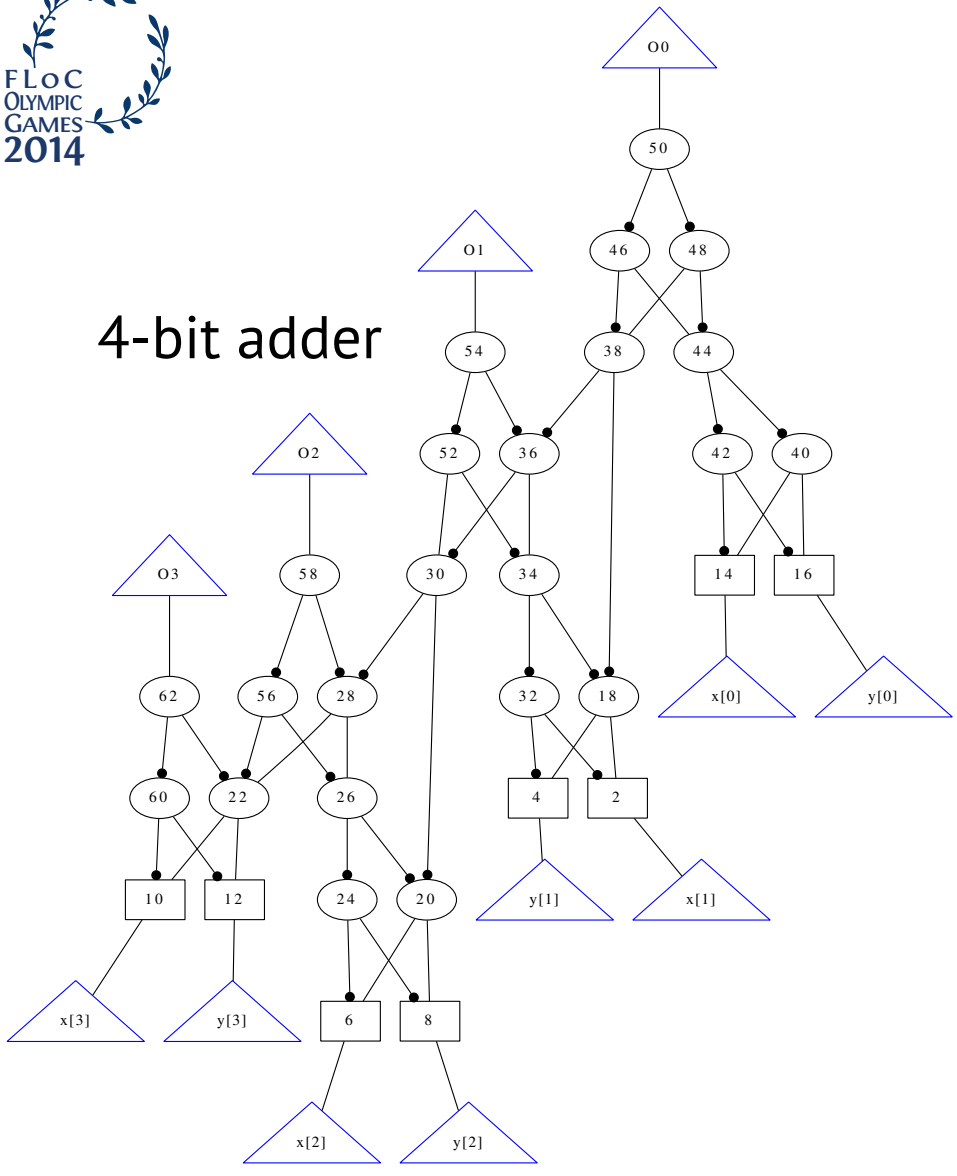
- founding lunch at CAV'06, first competition at CAV'07
- HWMCC lunch at FMCAD'08 $\Rightarrow$ need multiple properties !!!
- HWMCC'10 at CAV'10 (FLOC'10), since HWMCC'11 with FMCAD
- HWMCC'11: old *single*, new *live*ness and new *multi* property track
- HWMCC'12 as HWMCC'11, new *deep bounds track* sponsored by Oski
- HWMCC'13 identical to HWMCC'11-12 to stabilize format and rules
- HWMCC'14 as HWMCC'13: 1. deep, 2. single, 3. live no multi

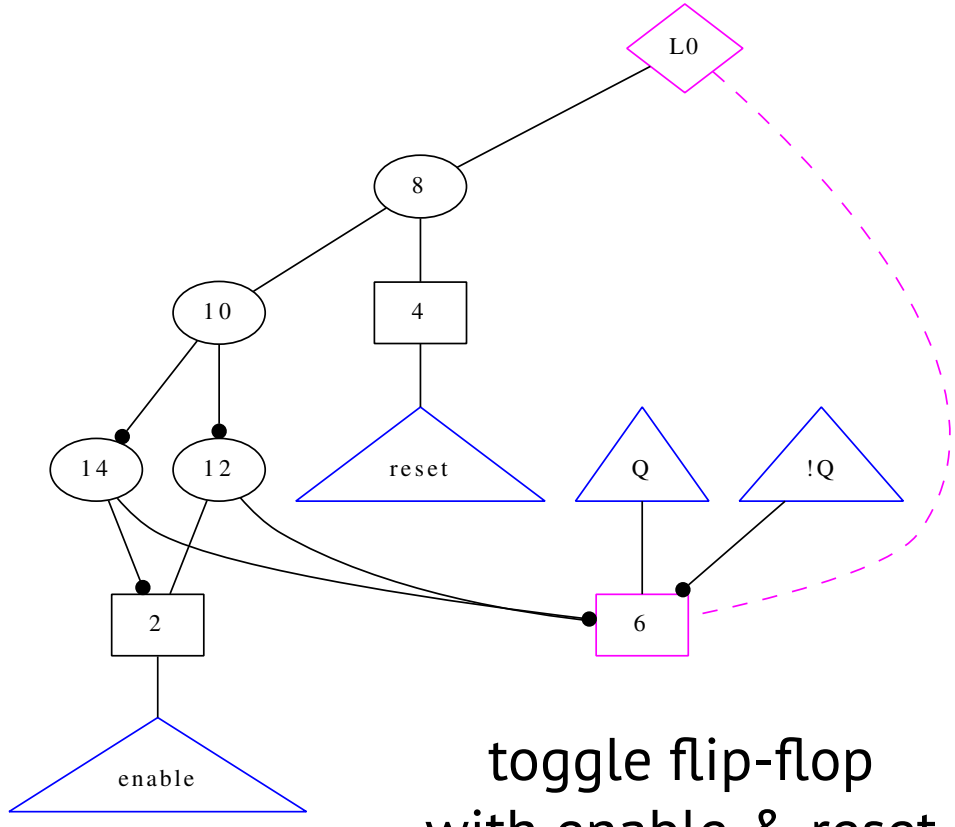
Goals

- hardware model checking
  - checking *temporal properties* of *hardware models*
    - software tool companies providing model checkers (EDA)
    - hardware companies using model checkers
    - sequential equivalence checking
  - model checking in industry still does not scale (enough)
    - manual abstractions / decomposition necessary
- repeat success of the SAT competition
  - improve state-of-the-art in empirical evaluations
  - **encourage model checking research**
  - **industrial impact**
- provide infra structure for comparing model checkers
  - simple AIGER and-inverter graph format
  - **benchmarks**

AIGER

4-bit adder





toggle flip-flop
with enable & reset

Setup

- required **witness traces**
  - single safety property track
- more powerful hardware at Aalto University
  - 32 nodes 2x Six-Core AMD Opteron 2435 2.6GHz, 16 GB RAM
  - thus **12 cores** for each solver per benchmark
  - memory limit **15 GB**, time limit of 900 seconds
- new benchmarks
  - generated from 6s suite from IBM
  - one new benchmark set from Oski
- 11 participating groups, 24 solver variants
  - preliminary versions were due June 1st, final version June 15
- three tracks, three Gödel medals
  - additional prize money $500 for deep bound track
  - each team only gets at-most one medal

Deep Bound Track

- 1st Prize: **TIP**
  Niklas Sörrenson, Koen Claessen
  Chalmers University of Technology

  (Gödel Medal +
  $500 check sponsored by Oski)

- 2nd Prize: **ShiftBMC**
  Norbert Manthey
  Technical University of Dresden

- 3rd Prize: **NuXMV**
  Alberto Griggio, Marco Roveri,
  Alessandro Cimatti
  Fondazione Bruno Kessler, Trento

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Deep Bound Track

79 benchmarks remain unsolved in the 'single' track:

6s309b034 6s29 intel032 6s342rb122 6s280r 6s340rb27 oski1rub09i 6s45 6s268r 6s392r intel066 6s35 6s24 intel048 beemkrebs4b1 6s387rb181 intel027 intel016 6s398b09 6s44 6s351rb02 6s365r 6s382r 6s188 oski1rub01i 6s195 beemskbn2b1 6s274r beemextnc1b1 6s22 6s329rb20 intel012 6s366r bob12s06 intel067 6s267rb3 6s33 6s279r 6s284rb1 6s39 6s13 6s171 6s377r 6s329rb19 6s322rb646 6s23 beemloyd3b1 6s399b02 6s160 nusmvdme116 6s399b03 6s339rb19 bobsmminiuart 6s402rb0342 oski2ub0i 6s148 bobsmcodic 6s398b16 bobpcihm intel065 6s516r oski1rub08i 6s367r 6s387rb291 6s517rb0 6s340rb63 6s514r 6s393r oski1rub00i beemptrsn7f1 6s376r 6s161 oski1rub10i 6s105 6s119 6s266rb2 oski1rub02i 6s341r intel013

Deep Bound Track

solver	score	sum capped bounds
tipbmc	93.28	3535
blimc*	92.61	3468
shiftbmc	92.52	3315
aigbmc*	92.26	3132
nuxmv	91.93	2787
v3	91.88	3154
v3db	91.83	3250
supdeep	87.82	3335
tip	83.18	589
iimc	15.91	655

* = hors concours

79 unsolved benchmarks
reached bounds capped at 100

$$\text{score} = \frac{1}{79} \sum_{i=1}^{79} 1 - 1/(2 + \text{bound}_i)$$

Single Safety Property Track

- 1st Prize: **ABC**
  Baruch Sterin, Robert Brayton,
  Niklas Eén, Alan Mishchenko
  University of California at Berkeley

  (Gödel Medal)

- 2nd Prize: **V3**
  Cheng-Yin Wu, Chung-Yang (Ric) Huang
  National Taiwan University, Taipei

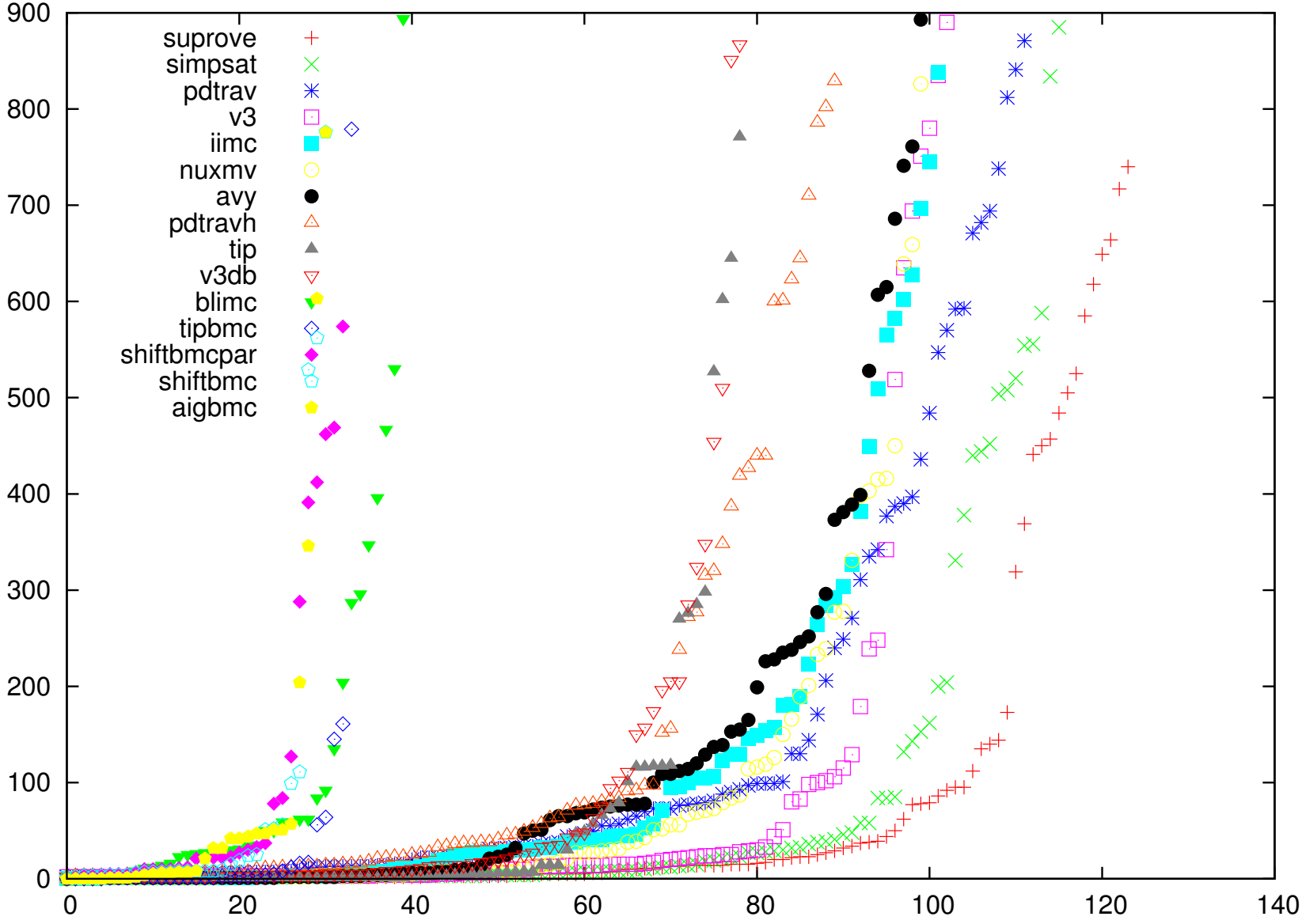
- 3rd Prize: **IIMC**
  Michael Dooley, Fabio Somenzi,
  Zyad Hassan, Aaron Bradley
  University of Colorado at Boulder

Single Safety Property Track

solver	ok	sat	uns	fld	to	mo	sig	uk	real	time	space	max
suprove	124	46	78	106	97	7	0	2	9746	59412	184515	12886
simpsat	116	50	66	114	101	9	0	4	9205	80997	192784	13590
pdtrav#	111	35	76	119	117	1	0	0	15353	62504	171842	12137
v3	103	36	67	127	121	1	5	0	7754	48806	102596	9190
iimc	102	36	66	128	126	0	2	0	10953	70839	82053	5986
nuxmv	100	31	69	130	115	15	0	0	8035	39136	163217	14140
avy	100	30	70	130	123	7	0	0	11361	64809	174491	8587
pdtravh#	89	25	64	141	120	4	10	6	11834	62383	152693	14951
tip	79	27	52	151	151	0	0	0	4894	4855	5804	678
v3db	79	37	42	151	145	6	0	0	5818	27700	115127	8898
blimc*	40	38	2	190	171	2	0	17	4431	4415	9949	1312
tipbmc	34	34	0	196	150	2	0	44	1296	1278	3757	541
shiftbmcpar	33	33	0	197	185	10	0	2	3217	10125	41764	12713
shiftbmc	31	31	0	199	164	13	0	22	2423	2410	11570	3070
aigbmc*	31	31	0	199	188	7	0	4	2445	2434	10350	1436
supdeep	0	0	0	230	36	53	0	141	0	0	0	0

= discrepancy, sprove,simpsat,supdeep = ABC, * = hors concours

Single Safety Property Track



Liveness Track

- 1st Prize: **ABC**
  Baruch Sterin, Robert Brayton,
  Niklas Eén, Alan Mishchenko
  University of California at Berkeley
- 2nd Prize: **IIMC**
  Michael Dooley, Fabio Somenzi,
  Zyad Hassan, Aaron Bradley
  University of Colorado at Boulder

  (Gödel Medal)

- 3rd Prize: **NuXMV**
  Alberto Griggio, Marco Roveri,
  Alessandro Cimatti
  Fondazione Bruno Kessler, Trento

Liveness Track

solver	ok	sat	uns	fld	to	mo	s11	uk	real	time	space	max
simplive	177	97	80	46	42	4	0	0	9924	69034	319271	12962
iimc	161	94	67	62	58	0	4	0	5514	16335	73089	13380
nuxmv	161	92	69	62	60	2	0	0	6431	30856	122949	7270
tiprbmc	128	62	66	95	95	0	0	0	9715	9650	2924	180
v3	111	64	47	112	64	3	45	0	9734	48047	53340	7691
ls4	97	65	32	126	106	20	0	0	4168	4124	87813	13346
tip	82	15	67	141	141	0	0	0	5965	5928	787	83
aigbmc*	63	63	0	160	134	1	0	25	5835	5808	2802	400

simplive = ABC

* = hors concours

Liveness Track