XCSP3 Competition 2019
– Results –

http://www.cril.fr/XCSP19/

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XCSP3 and its Ecosystem:

- XCSP3: an XML-based format designed to represent instances of combinatorial constrained problems
- MCSP3: a Java-based API for modeling problems and compiling them into XCSP3

Many tools are available on github (https://github.com/xcsp3team/):

- Parsers (Java 8, C++ 11)
- a tool for checking solutions and bounds
- a tool for checking the validity of an instance for a competition track

Many series of CSP/COP instances that can be downloaded from `www.xcsp.org` by means of our selection engine!

Outline

Purpose of Competitions

The goal of a competition is to:

- evaluate solvers in the same conditions
- help collecting publicly available benchmarks and data (results, traces, ...)
- help the community identify good ideas and strange results: the goal is to raise questions and get new ideas!

Competitions should not be misunderstood:

- The results are not an absolute truth: they depend on the benchmark selection, experimental conditions, ...
- A competition is not limited to a ranking: rankings are just an over-simplified view, but still relevant to motivate authors
- Competitions must be driven by the community: benchmark submission/selection advices, suggestions for improvements, ...

Perimeter of Constraints (mainly, XCSP3-core)

For the standard tracks:

- `intension`, `extension`
- `regular` and `mdd`
- `allDifferent`, `allEqual`, `ordered` and `lex`
- `sum`, `count`, `nValues` and `cardinality`
- `maximum`, `minimum`, `element` and `channel`
- `noOverlap` and `cumulative`
- `circuit` and `instantiation`
- `slide`

For the Mini-solver tracks:

- `intension`, `extension`
- `allDifferent`
- `sum`
- `element`

Tracks for the 2019 XCSP3 Competition

There are 6 Standard tracks and 2 Minisolver tracks.

Problem	Goal	Exploration	Timeout
CSP	one solution	sequential	40 minutes
CSP	one solution	parallel	40 minutes
COP	best solution	sequential	4 minutes
COP	best solution	sequential	40 minutes
COP	best solution	parallel	40 minutes

Table: Standard Tracks.

Problem	Goal	Exploration	Timeout
CSP	one solution	sequential	40 minutes
COP	best solution	sequential	40 minutes

Table: Mini-Solver Tracks.

Computer Infrastructure

- The cluster we used is provided by CRIL and is composed of nodes with two quad-cores (Intel @ 2.67GHz with 32 GiB RAM).
- Hyperthreading was disabled.
- Sequential solvers were run on one processor (4 cores) and were allocated 15500 MiB of memory.
- Parallel solvers were run on two processors (8 cores) and were allocated 31000 MiB of memory.

Selection of Benchmarks

Automatic selection based on the estimated difficulty of instances. The top 3 solvers of the 2018 competition were used to estimate the difficulty of each instance (defined as the average PAR2 time).

Main rules for the selection:

- 10% of **easy** instances (PAR2 score $<$ 2 minutes)
- 35% of **medium** instances (PAR2 score between 2 and 30 minutes)
- 35% of **hard** instances (PAR2 score between 30 and 80 minutes)
- 20% of **open** instances (unsolved by any solver in the top 3)
- At most 10 instances can be selected per series
- At least 10 instances in new series (only 2 new series submitted)

In the end, from a random automatic procedure (selection code and seed available), we got:

- Standard tracks: 300 CSP and 300 COP instances
- Mini-solver tracks: 200 CSP and 180 COP instances

Rankings

- The main ranking is based on the number of times a solver is able to prove a result (satisfiability, optimality). Ties are broken on the cumulated time.
- The CPU ranking is obtained by allowing at most 40' of CPU time (4' for fast COP)
- The wallclock ranking is obtained by allowing at most 40' of wallclock time (4' for fast COP)
- Allows to compare sequential and parallel solvers (denoted by a grey background in the rankings).
- Other rankings defined on the number of best answers given (see web site).

Outline

Teams/Solvers (in alphabetic order)

Abscon	C. Lecoutre
BTD, miniBTD	D. Habet, P. Jégou, H. Kanso, C. Terrioux
Choco-solver	C. Prud'homme, J.-G. Fages
Concrete	J. Vion
cosoco	G. Audemard, N. Szczepanski
Fun-sCOP	T. Soh, D. Le Berre, H. Nabeshima, M. Banbara, N. Tamura
NACRE	G. Glorian
PicatSAT	N.-F. Zhou

Main track, CSP, CPU ranking

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 300					
Virtual Best Solver (VBS)		272	177 SAT, 95 UNSAT	91%	100%
1	PicatSAT	245	163 SAT, 82 UNSAT	82%	90%
2	Fun-sCOP *hybrid+CryptoMiniSat*	209	132 SAT, 77 UNSAT	70%	77%
3	Fun-sCOP *hybrid+ManyGlucose*	198	121 SAT, 77 UNSAT	66%	73%
4	Fun-sCOP *order+ManyGlucose*	192	122 SAT, 70 UNSAT	64%	71%
5	Fun-sCOP *order+GlueMiniSat*	190	122 SAT, 68 UNSAT	63%	70%
6	AbsCon	167	114 SAT, 53 UNSAT	56%	61%
7	Concrete	156	106 SAT, 50 UNSAT	52%	57%
8	choco-solver *parallel*	153	113 SAT, 40 UNSAT	51%	56%
9	choco-solver	149	101 SAT, 48 UNSAT	50%	55%
10	BTD	135	84 SAT, 51 UNSAT	45%	50%
11	cosoco	126	82 SAT, 44 UNSAT	42%	46%
12	cosoco *parallel*	121	86 SAT, 35 UNSAT	40%	44%

SAT based solvers are doing very well!

Main track, COP, CPU ranking

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 300					
Virtual Best Solver (VBS)		234	232 OPT, 2 UNSAT	78%	100%
1	PicatSAT	221	219 OPT, 2 UNSAT	74%	94%
2	choco-solver *parallel*	210	208 OPT, 2 UNSAT	70%	90%
3	AbsCon	191	189 OPT, 2 UNSAT	64%	82%
4	choco-solver	180	179 OPT, 1 UNSAT	60%	77%
5	Concrete	170	169 OPT, 1 UNSAT	57%	73%
6	cosoco *parallel*	136	135 OPT, 1 UNSAT	45%	58%
7	cosoco	117	116 OPT, 1 UNSAT	39%	50%

Parallel solvers can beat sequential solvers, even in a CPU ranking.

Main track, CSP, wallclock ranking

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 300					
Virtual Best Solver (VBS)		272	177 SAT, 95 UNSAT	91%	100%
1	PicatSAT	245	163 SAT, 82 UNSAT	82%	90%
2	Fun-sCOP *hybrid+ManyGlucose*	219	137 SAT, 82 UNSAT	73%	81%
3	Fun-sCOP *order+ManyGlucose*	210	135 SAT, 75 UNSAT	70%	77%
4	Fun-sCOP *hybrid+CryptoMiniSat*	209	132 SAT, 77 UNSAT	70%	77%
5	Fun-sCOP *order+GlueMiniSat*	190	122 SAT, 68 UNSAT	63%	70%
6	choco-solver *parallel*	185	131 SAT, 54 UNSAT	62%	68%
7	AbsCon	167	114 SAT, 53 UNSAT	56%	61%
8	Concrete	156	106 SAT, 50 UNSAT	52%	57%
9	choco-solver	149	101 SAT, 48 UNSAT	50%	55%
10	cosoco *parallel*	147	96 SAT, 51 UNSAT	49%	54%
11	BTD	135	84 SAT, 51 UNSAT	45%	50%
12	cosoco	126	82 SAT, 44 UNSAT	42%	46%

Sequential solvers can beat parallel solvers, even in a wallclock ranking.

Main track, COP, wallclock ranking

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 300					
Virtual Best Solver (VBS)		234	232 OPT, 2 UNSAT	78%	100%
1	PicatSAT	221	219 OPT, 2 UNSAT	74%	94%
2	choco-solver *parallel*	217	215 OPT, 2 UNSAT	72%	93%
3	AbsCon	191	189 OPT, 2 UNSAT	64%	82%
4	choco-solver	180	179 OPT, 1 UNSAT	60%	77%
5	Concrete	173	172 OPT, 1 UNSAT	58%	74%
6	cosoco *parallel*	160	158 OPT, 2 UNSAT	53%	68%
7	cosoco	117	116 OPT, 1 UNSAT	39%	50%

Fast COP track, CPU ranking

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 300					
Virtual Best Solver (VBS)		234	232 OPT, 2 UNSAT	78%	100%
1	AbsCon	162	160 OPT, 2 UNSAT	54%	69%
2	PicatSAT	150	149 OPT, 1 UNSAT	50%	64%
3	choco-solver *parallel*	143	142 OPT, 1 UNSAT	48%	61%
4	choco-solver	120	119 OPT, 1 UNSAT	40%	51%
5	cosoco *parallel*	90	89 OPT, 1 UNSAT	30%	38%
6	Concrete	88	87 OPT, 1 UNSAT	29%	38%
7	cosoco	87	87 OPT	29%	37%

Fast COP track, wallclock ranking

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 300					
Virtual Best Solver (VBS)		234	232 OPT, 2 UNSAT	78%	100%
1	choco-solver *parallel*	204	202 OPT, 2 UNSAT	68%	87%
2	AbsCon	162	160 OPT, 2 UNSAT	54%	69%
3	PicatSAT	150	149 OPT, 1 UNSAT	50%	64%
4	cosoco *parallel*	133	131 OPT, 2 UNSAT	44%	57%
5	choco-solver	120	119 OPT, 1 UNSAT	40%	51%
6	Concrete	91	90 OPT, 1 UNSAT	30%	39%
7	cosoco	87	87 OPT	29%	37%

CPU and wallclock rankings are quite different.

Mini-solvers, CSP

Rank	Solver	#solved	Detail	%inst.	%VBS
Total number of instances: 200					
Virtual Best Solver (VBS)		172	109 SAT, 63 UNSAT	86%	100%
	PicatSAT *(reference)*	148	97 SAT, 51 UNSAT	74%	86%
1	NACRE *Hybrid*	135	91 SAT, 44 UNSAT	68%	78%
2	miniBTD	133	89 SAT, 44 UNSAT	67%	77%
3	cosoco	127	85 SAT, 42 UNSAT	64%	74%
4	NACRE	116	81 SAT, 35 UNSAT	58%	67%

Note: PicatSAT was not submitted to the mini-solvers track, but included for comparison.

To Conclude

All Details about the Competition

On http://www.cril.fr/XCSP19/, many tables/diagrams and plots can be found. Also, you can get the traces of any solver.

Forthcoming

PyCSP3, A Python library to build models and to compile towards XCSP3 (*Release in October 2019*). PyCSP3 has strong connections with MCSP3 and Numberjack (and now, CPpy).

Example : Send+More=Money

```
from pycsp3 import *

letters = VarArray(size=8, dom=range(10))
s, e, n, d, m, o, r, y = letters

satisfy(
    AllDifferent(letters),
    s > 0,
    m > 0,
    [s+m, e+o, n+e, d+y] * [1000, 100, 10, 1] == [m, o, n, e, y] * [10000, 1000, 100, 10, 1]
)
```