

# Separation Logic Competition SL-COMP 2018

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Workshop ADSL 2018, July 13th

# Outline

Static Results

Dynamic Results

Conclusion and Future

# SL-COMP

Started in 2014 as a satellite event of SMT-COMP 2014:

- Objectives:
  - promote the implementation effort on solvers for SL
  - share a benchmark of interesting problems
  - compare techniques
- Results:
  - 6 solvers
  - 678 problems, 25% sat and 75% entailment
  - common input format based on SMT-LIB 2.0
  - 5 divisions of (mainly) **quantifier free** formulas in the **symbolic heap** fragment with specific (e.g., *lseg*) or general inductive definitions

# The second edition, SL-COMP 2018

Same objectives, **new results**:

- **new cleaner input format**, aligned with SMT-LIB 2.6
- **+618** ( $\sim +100\%$ ) new benchmarks, fixes some old ones
- **+6** divisions, better naming
- **+4** (initially +6) solvers
- **gain in visibility**

# Input Format

Work done by Adrew J. Reynolds, Cristina Serban and Radu Iosif

Start with the SMT-lib 2.6 (2017) including

- `datatypes` used to define types of heap cells
  - locations are abstract sorts
- `funs-rec` used for inductive heap predicates

```
(declare-sort RefCell 0)
```

```
(define-datatype Cell ((cons (data Int) (next RefCell)))
```

## Input Format

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```
(declare-sort RefCell 0)
```

```
(define-datatype Cell ((cons (data Int) (next RefCell)))
```

Extend with a new command for heap typing

```
(declare-heap (RefCell Cell) (RefTree Tree))
```

## Input Format (cont.)

Theory SepLogTyped has no predefined sorts but new operators:

```
:funs ((emp Bool)
      (sep Bool Bool Bool :left-assoc)
      (wand Bool Bool Bool :right-assoc)
      (par (L D) (pto L D Bool))
      (par (L) (nil L)) )
```

Logics are defined as usual in SMT-lib.

Free variables are declared as constants (SMT-lib style)

Problems are either:

- sat, input is a set of assertions
- ent1, input is two assertions,  $\varphi$  followed by  $\neg\psi$ , to check  $\varphi \models \psi$

# Division Naming

Division = a logic + a problem

- 8 divisions in SL-COMP'18 (+5 wrt 2014)

Naming follows rules of SMT-lib

- prefix *QF\_* for quantifier free (SMT-lib)
- *LIA* for linear arithmetics (SMT-lib)
- *SH* for symbolic heaps
- *BSL* for boolean combination
- *ID* for general well-formed (SMT-lib) inductive definitions
- *LID* for linear ID (lists, nested lists, skip lists)

Example: `qf_shidlia_ent1`



## Collected Problems by Division

Division	#problems
qf_bsl_sat	46
qf_bsllia_sat	24
qf_shid_entl	311
qf_shid_sat	99
qf_shidlia_entl	75
qf_shidlia_sat	33
qf_shlid_entl	59
qf_shls_entl	296
qf_shls_sat	110
shid_entl	73
shidlia_entl	181

## Participants

Old fellows (6):

- **Asterix**: A. Rybalchenko (MSR), J.A. Navarro Perez (Google)
- **CYCLIST** & **SLSAT**: N. Gorogiannis (Middlesex U.)
- **SLEEK**: B. Lee, C. Wei Ngan (NUS)
- **SLIDE**: R. Iosif (Verimag); A. Rogalewicz (TU Brno)
- **SPEN**: C. Enea, M.S. (UPD); T. Vojnar, O. Lengal (TU Brno)

New fellows (4 + 3):

- *ComSPEN*: C. Gao, Z. Wu (Acad. China)
- **CVC4**: A. J. Reynolds (U. Iowa)
- **Harrsh**: J. Katelaan (TU Vienna)
- *Inductor*: R. Iosif, C. Serban (Verimag)
- **S2S**: L. Le Quang (Teesside U.)
- *Sloth*: J. Katelaan (TU Vienna)
- **Songbird**: T. Ta Quang, C. Wei Ngan (NUS)

## Participants by Underlying Technique

- *SMT solving*: Asterix, CVC4, SLSAT
- *Small model and SMT*: ComSPEN, Sloth
- *Automata*: Harrsh, SLIDE, SPEN
- *Proofs*: SLEEK, SPEN
- *Cyclic proofs*: CYCLIST, S2S, Songbird

## Collected Set of Benchmarks

Division	size	Solver
qf_bsl_sat	46	CVC4
qf_bsllia_sat	24	CVC4
qf_shid_ent1	312	CYCLIST, S2S, SLEEK, SLIDE, Songbird, SPEN
qf_shid_sat	99	CYCLIST, Harrsh, S2S, SLEEK
qf_shidlia_ent1	61	ComSPEN, S2S
qf_shidlia_sat	33	ComSPEN, S2S
qf_shlid_ent1	60	ComSPEN, SPEN
qf_shls_ent1	296	Asterix, S2S, SPEN
qf_shls_sat	110	Asterix
shid_ent1	73	SLEEK, Songbird
shidlia_ent1	181	Songbird

... and in a diagram

## Execution on StarExec

**NB:** rules are not clearly stated, very flexible, on demand  
Yet,

- solver binary running on StarExec
  - pull out 2 solvers!
- by default: 600 sec of timeout and 4 GB of memory
  - initially 120 sec and 1 GB, request to increase
  - timeout increased to 2400 then 3600 if resourced out
- 3 or 4 rounds, depending on
  - availability of the final version of the solver
  - number of resourced out problems

## Division *qf\_shls\_entl*

- Origin: *sll0a\_entl* of SL-COMP'14
- 7 solvers, 296 problems
- mainly run with 600 sec and 4GB
- too much wrong results
  - a problem in pre-processors?
  - inconsistency of solvers?

Entry division, includes problems that reveal solver's corner cases.

## Division *qf\_shls\_sat*

- Origin: *sll0a\_sat* of SL-COMP'14
- 7 solvers, 110 problems
- mainly run with 600 sec and 4GB
- PTIME algorithm, not for proof techniques

Asterix is still the best!

## Division *qf\_shid\_entl*

- Origin: *UDB\_entl* of SL-COMP'14
- 6 solvers, 312 problems
- interesting runs when timeout is  $\geq 2400$ 
  - yet, some problems are easy (see SPEN-TA)
  - a lot of wrong results!

Definitively a difficult division!



## Division *qf\_shlid\_entl*

- Origin: *FDB\_entl* of SL-COMP'14
  - ID with linear form, have a PTIME algorithm
- 6 solvers, 60 problems
- fragment not clearly defined, so many wrong results

Put on show S2S!

but

Work to do on the benchmark!

## Division *shid\_entl*

- Origin: *UDB\_entl* of SL-COMP'14
  - incorrectly classified QF
  - mainly quantifiers in consequent
- 5 solvers, 73 problems
- Execution timeouts set to 2400 sec at least

Put on show Songbird!

## Division *qf\_shid\_sat*

- Origin: *UDB\_sat* of SL-COMP'14
- 7 solvers, 99 problems
- Impressive differences in execution times
- Some problems to be fixed with 9 problems or in the pre-processors

Put on show SLSAT!

## Divisions *qf\_bsl\_sat* and *qf\_bsllia\_sat*

- New, problems mainly provided by CVC4
- 1(+/1/) solver
- Question: what to do with magic wand?

Need for solvers to challenge CVC4!

## Division *qf\_shidlia\_entl*

- New, problems from proof based solvers
- 3 solvers, 61 problems
- Execution times differ very much

Put on show Songbird!

## Division *qf\_shidlia\_sat*

- New, problems from proof based solvers
- 3 solvers, 33 problems

Put on show S2S!

## Division *shidlia\_entl*

- New, problems from proof based solvers
- 3 solvers, 181 problems
- Execution timeouts shall be  $\geq 2400$  sec

Put on show Songbird!

# Conclusion and Future

## Successful edition:

- new benchmark for interesting logics
  - extension with arithmetics and boolean combination
- clean input and tools supporting it
  - C++ and Ocaml parser and checkers (typing, logic)
- new solvers, old ones are still competitive

## Future:

- clean existing benchmark based on analysers
- fix problems of running on StarExec for some solvers
- fix inconsistency in solvers and pre-processors
- **Toolympics at ETAPS 2019:**
  - competition presentation: accepted
  - official publication in ETAPS proceedings?
  - re-run for April 2019??