SL-COMP

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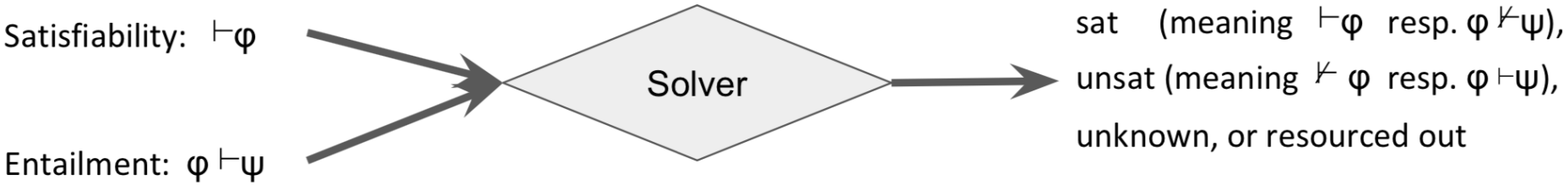
TOOLympics 2019, April 7th

SL-COMP: Competition of Solvers for Separation Logic



- Goals:
  - share state of the art and a set of challenging probl
  - improve solvers for SL used in verification tools
  - compare solving (semi-)decision procedures and related techniques
- History:
  - 2014: at FLOC, 6 solvers, 600 problems, 5 divisions
  - 2018: at FLOC, 11 solvers *registered*, 1268 problems, 11 divisions
  - 2019: 11 solvers participated

Input

Entailment or satisfiability problem for formulas in

- many sorted Separation Logic theory

$$\begin{array}{rcl} \varphi & ::= & \mathsf{emp} \mid \mathsf{t} \mapsto \mathsf{u} \mid \varphi_1 * \varphi_2 \mid \varphi_1 \wedge \varphi_2 \mid \exists x^{\sigma} \ . \ \varphi_1(x) \mid P(x_1, \ldots, x_n) \\ & & \mathsf{t}\#\mathsf{u} \mid \varphi_1 \mathrel{-\!\!*} \varphi_2 \mid \neg\varphi_1 \end{array}$$

- with predicates defined by sets of rules

$$P(x_1, \ldots, x_n) \quad \leftarrow \quad \varphi(x_1, \ldots, x_n),$$

Example of Input Problem

Sorts: `Loc`, `Data` and `Int`

$$x \mapsto \mathtt{node}(1, y) \ * \ y \mapsto \mathtt{node}(1, z) \ * \ \mathtt{ls}(z, \mathsf{nil}) \ \wedge \ z \neq x \quad \vdash \quad \mathtt{ls}(x, \mathsf{nil})$$

where

$$\begin{array}{lcl} \mathtt{ls}(h, f) & \leftarrow & h = f \wedge \mathsf{emp} \\ \mathtt{ls}(h, f) & \leftarrow & \exists x, i \ . \ h \neq f \ \wedge \ h \mapsto \mathtt{node}(i, x) \ * \ \mathtt{ls}(x, f) \end{array}$$

Input Format

Based on SMT-LIB 2.6:

```
(theory SepLogicTyped

 :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))
        )
)
```

extended with command `declare-heap` to fix type of heap (i.e., `L` and `D`).

Example of Input (Excerpt)

```
(set-logic QF_SHIDLIA)
(set-info :status unsat)

(declare-sort Loc 0)
(declare-datatype Data ((node (d Int) (next Loc))))

(declare-heap (Loc Data))

(define-fun-rec ls ((h Loc) (f Loc)) Bool
    (or (and emp (= h f))
        (exists ((x Loc) (d Int))
                (and (distinct h f) (sep (pto h (node d x))
                                         (ls x f))))
    )
)
```

Fragments and Divisions

Division $\triangleq$ Fragment $\times$ Query

Division	#problems	Fragment, Query
`qf_shid_entl`	312	*qf* quantifier free
`qf_shid_sat`	99	*sh symbolic heaps*
`qf_shidlia_entl`	61	*id* user defined predicates
`qf_shidlia_sat`	33	*lid* linear ID
`qf_shlid_entl`	60	*ls* list segment ID
`qf_shls_entl`	296	*entl* entailment
`qf_shls_sat`	110	*sat* satisfiability
`shid_entl`	73	*lia* SMT LIA
`shidlia_entl`	181	
`qf_bsl_sat`	46	*bsl* boolean combination
`qf_bsllia_sat`	24	

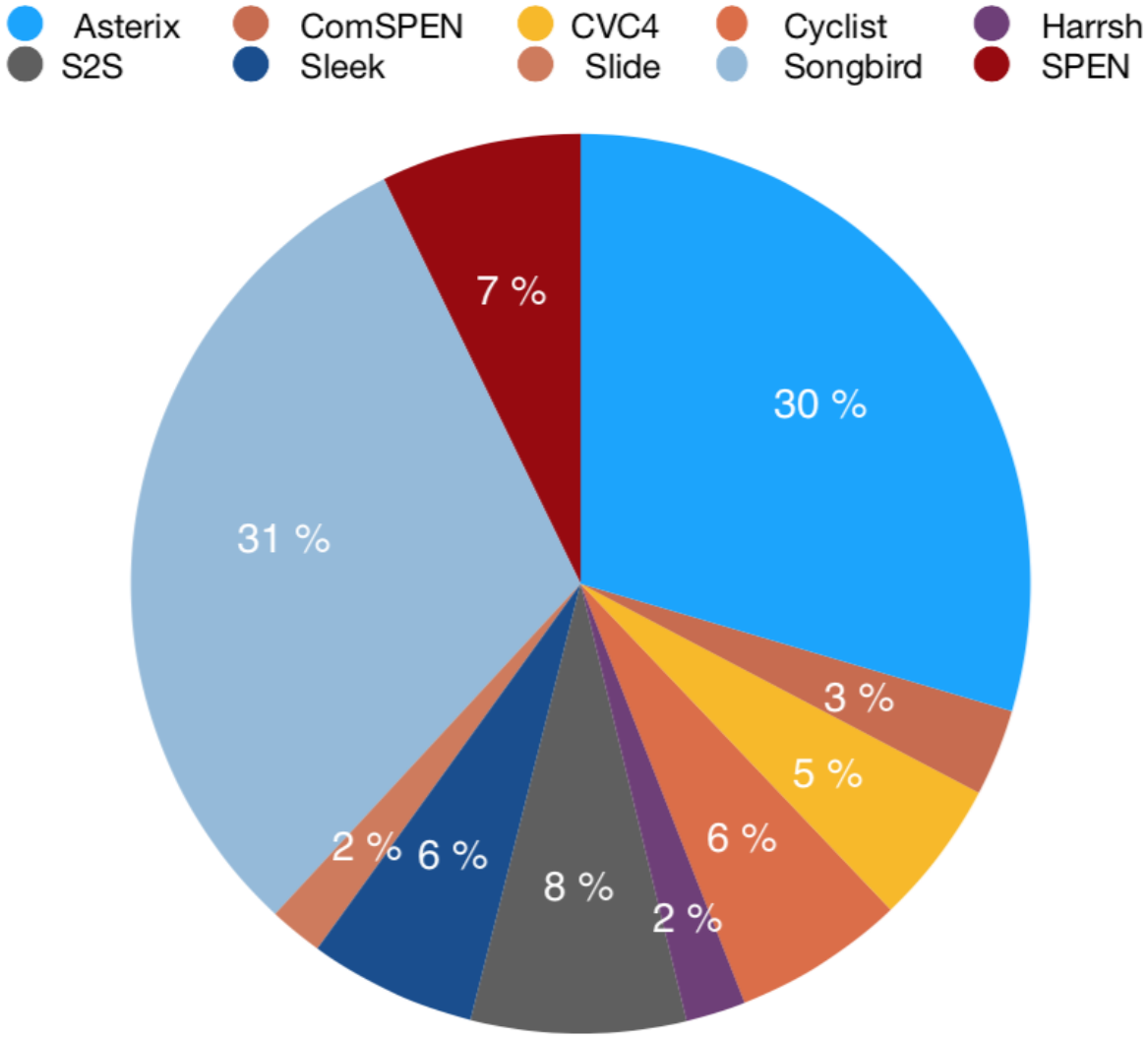
Process and Places

- On `sl-comp@googlegroups.com`
  - Call for solvers (and its *contact person*)
  - Call for problems
- On `github.com/sl-comp/`
  - Publication of the benchmark set
  - Tools for parsing input format and StarExec output
- Execution on StarExec
  - SL community
  - Space SL-COMP-YY
  - Several training runs before the final run
  - Configuration: memory 10 GB and timeout 600 or 2400 seconds
- On `sl-comp.github.io`: results on readable format

Participants

Solver	Affiliation	Team
Asterix	TU Munich, Germany	A. Rybalchenko (MSR), J.A. Navarro Pérez (Google)
ComSPEN	ISCAS, China	C. Gao, Z. Wu
CVC4-SL	University of Iowa, USA	A. J. Reynolds
Cyclist & SLSAT	Middlesex University London, UK	N. Gorogiannis
Harrsh	TU Wien, Austria RWTH Aachen University, Germany	J. Katelaan, F. Zuleger Ch. Matheja, T. Noll
S2S	Teesside University, Middlesbrough, UK	Quang Loc Le
SLEEK	NUS, Singapore	Wei-Ngan Chin, Benjamin Lee
SLIDE	FIT, Brno University of Technology, Czechia VERIMAG, Univ. of Grenoble & CNRS, France	M. Cyprian, A. Rogalewicz, T. Vojnar R. Iosif
Songbird	NUS, Singapore Stevens Institute of Technology, USA	Wei-Ngan Chin, Quang-Trung Ta, Thanh-Toan Nguyen, Siau-Cheng Khoo Ton-Chanh Le
SPEN	IRIF, University of Paris & CNRS, France FIT, Brno University of Technology, Czechia	C. Enea, M. Sighireanu O. Lengal, T. Vojnar

Contribution to Benchmark Set



Scoring

- Schemes:
  - 2014, 2018: SMT-COMP scheme based on lexicographical ordering on
    - disqualification for an *unexpected* result ☹
    - number of solved problems
    - CPU time
  - 2019: Differential penalty scheme ordering on score
    $1 \times \mathit{solved} + (-1) \times \mathit{false\text{-}positives} + (-10) \times \mathit{false\text{-}negatives}$
    - *false-positives* sound for verification
    - points for contribution to VBS (Virtually Best Solver)
    - CPU time is the tiebreaker

Division qf_shls_entl

- 9 solvers, 296 problems
- Configuration: timeout 600 seconds, memory 10GB
- Podium:
  - *****: Asterix
  - ****: S2S
  - ***: SPEN
  - **: Songbird
  - *: ComSPEN
  - ☕: Cyclist-SL, Harrsh, SLEEK, SLIDE

Division qf_shid_sat

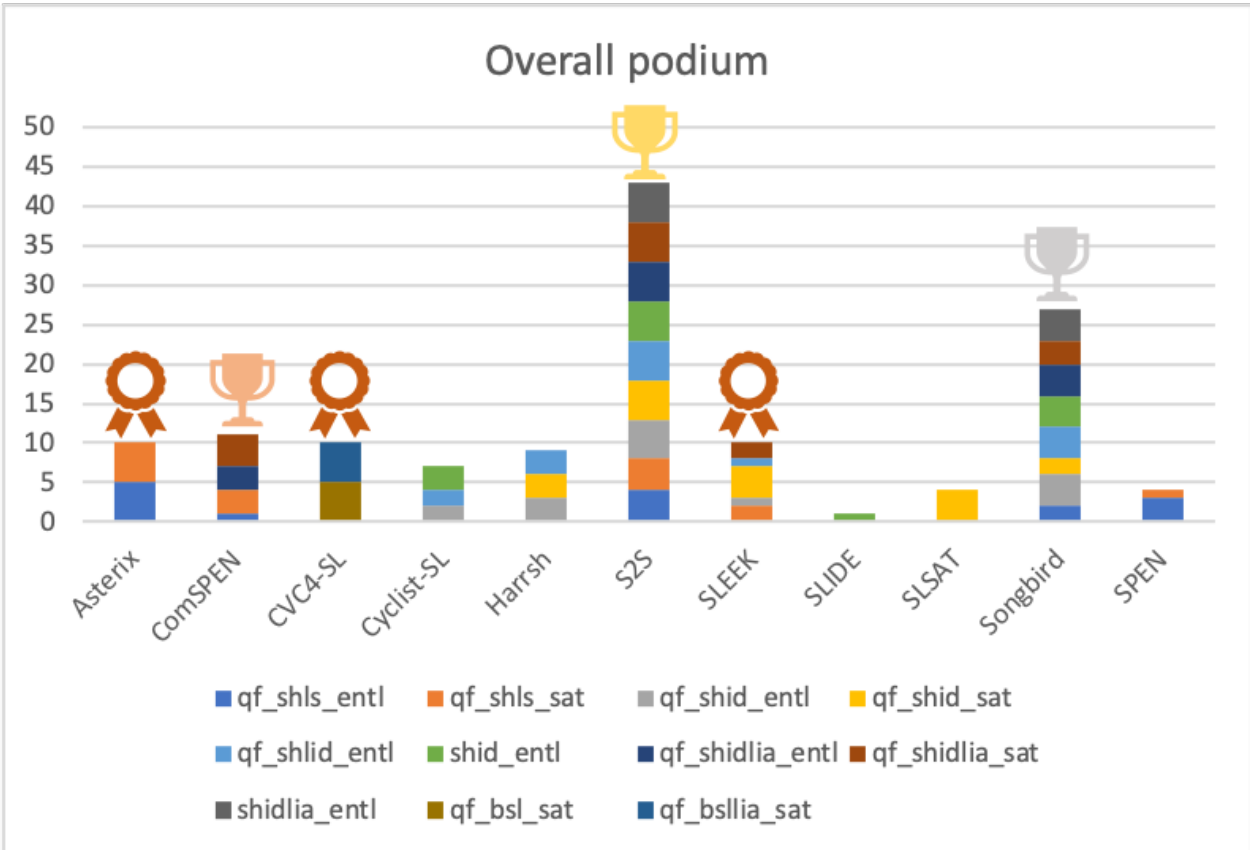
- 5 solvers, 99 problems
- Configuration: timeout 2400 seconds, memory 10GB
- Podium:
  - *****: S2S
  - ****: SLEEK, SLSAT
  - ***: Harrsh
  - **: Songbird

Points to SLSAT for contribution to VBS.

Division shid_entl

- 5 solvers, 73 problems
- Configuration: timeout 2400 seconds, memory 10GB
- Podium:
  - *****: S2S
  - ****: Songbird
  - ***: Cyclist-SL
  - **: SLIDE
  - *:
  - ☕: SLEEK (negative score)

Overview of Results



Conclusion and Future

Successful edition: many thanks to participants and StarExec

- consolidate newcomers
- old fellows still competitive on new problems
- compliance with the common input format based on SMT-LIB 2.6
- refinement of the scoring scheme
- visibility gain due to competition report at TACAS 2019

Future:

- improve the process: communication, selection of problems, scoring
- enrich the benchmark set with relevant verification problems
- next edition: at ADSL 2020 or FLOC 2022