Seminator 2 Can Complement Generalized Büchi Automata via Improved Semi-determinization

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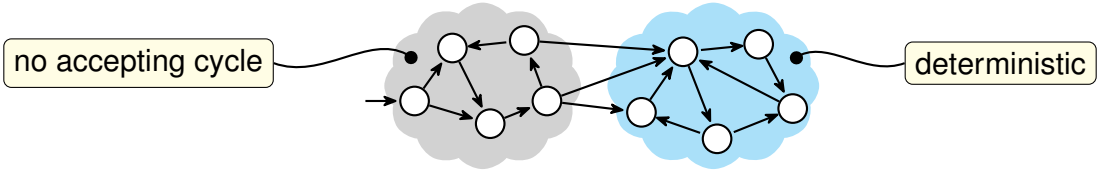
1. What are semi-deterministic automata? What is Seminator 2?
2. How good is it at semi-determinization?
3. How good is it at complementation?

Semi-deterministic ω-Automata



- a.k.a. *limit-deterministic* automata
- sufficient for some applications that traditionally used deterministic automata (e.g. qualitative model checking of MDPs)
- benefits:
  - can be smaller than deterministic automata
  - SDBA as expressive as NBA (i.e., more than DBA)

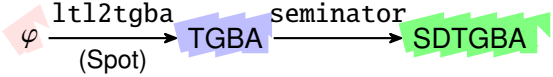
Seminator 2

- semi-determinization of TGBA
- built on Spot (reuses data-structures, I/O, automata simplifications)
- new in version 2:
  - near complete rewrite of the semi-determinization procedure (with many **new optimizations**)
  - **optional complementation** via semi-determinization

$$\text{TGBA} \xrightarrow{\text{semi-det.}} \text{SDTBA} \xrightarrow{\text{NCSB-compl.}} \text{TBA}$$

  - Python bindings (Seminator appears as a plugin for Spot)
  - pipe-friendly command-line interface

Semi-determinization: Comparison with Owl's `ltl2ldgba`



	(semi-)deterministic		not semi-deterministic	
	literature	random	literature	random
# of formulas:	200	1000	19	500
Seminator 1.1	787	4947	297	7020
Seminator 2	787	4947	230	3956

input already semi-deterministic
Seminator has nothing to do

sum of all
output states

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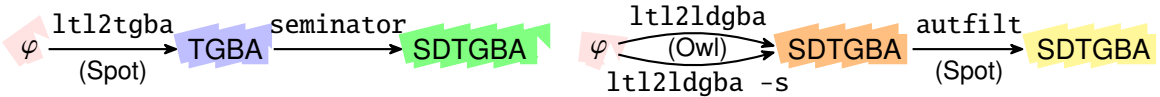

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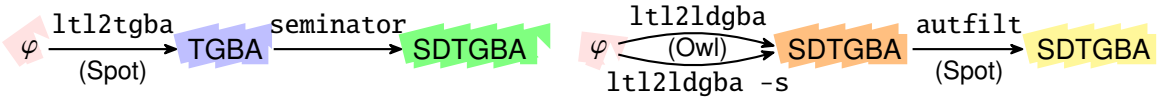

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# of formulas:	200	1000	19	500
Owl best	1092 (102)	6335 (454)	281 (6)	5041 (144)
Owl best + Spot	978 (139)	5533 (724)	234 (11)	4153 (268)
Seminator 1.1	787 (201)	4947 (963)	297 (7)	7020 (60)
Seminator 2	787 (201)	4947 (963)	230 (16)	3956 (356)

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# of cases with
smallest output

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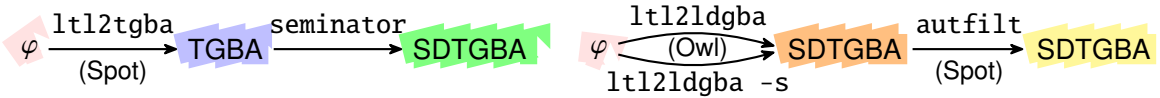

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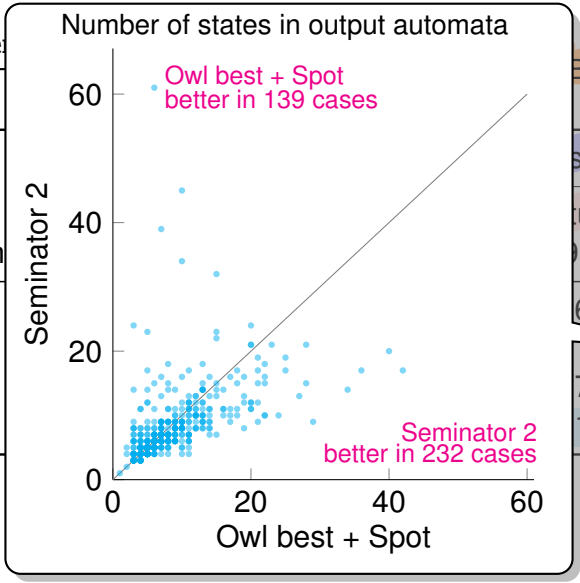
Semi-determinization: Comparison with Owl's `ltl2ldgba`

φ → `ltl2tgba` (Spot) → TGBA → se… → … → `autfilt` (Spot) → SDTGBA



semi-deterministic

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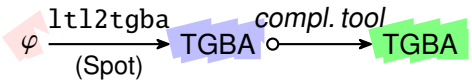
Complementation Evaluation



formulas with timeouts removed

	deterministic		semi-deterministic		not semi-deterministic	
	literature	random	literature	random	literature	random
# of formulas:	147	500	47	499	15	486

Spot	611	2477	190	2829	181	5310
Seminator 2	622	2511	210	2781	169	4919

even if input is (semi-)deterministic
Seminator still has to complement it

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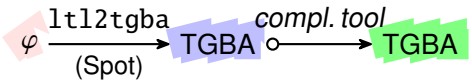

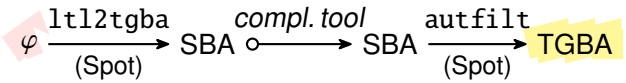

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ROLL + Spot	1388	3687	833	5681	272	6225
Fribourg + Spot	627	2493	290	3294	142	5278
GOAL + Spot	617	2490	277	3676	206	7713
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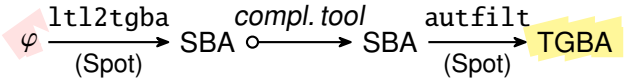

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ROLL + Spot	1388 (0)	3687 (0)	833 (0)	5681 (4)	272 (0)	6225 (58)
Fribourg + Spot	627 (137)	2493 (464)	290 (26)	3294 (258)	142 (14)	5278 (238)
GOAL + Spot	617 (143)	2490 (477)	277 (28)	3676 (125)	206 (5)	7713 (96)
Spot	611 (150)	2477 (489)	190 (40)	2829 (354)	181 (9)	5310 (202)
Seminator 2	622 (142)	2511 (465)	210 (37)	2781 (420)	169 (8)	4919 (277)

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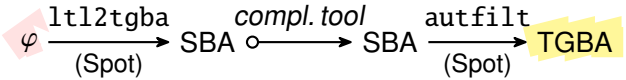

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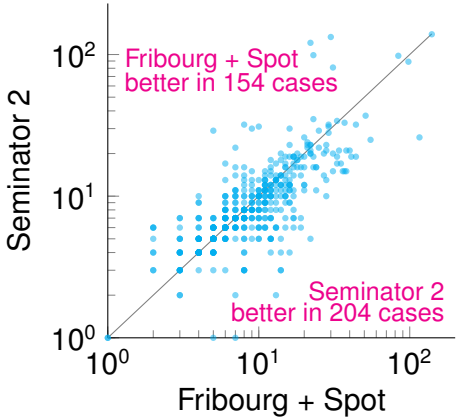
Complementation: Fribourg vs. Seminator 2 vs. Spot



(Number of states in complemented automata.)

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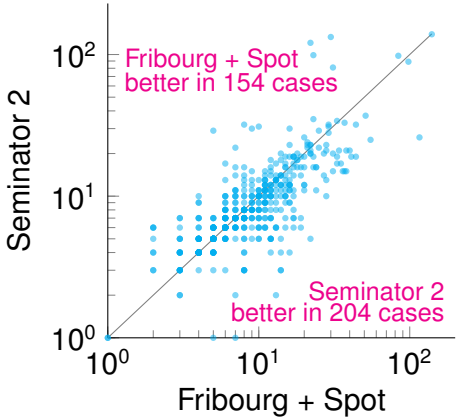

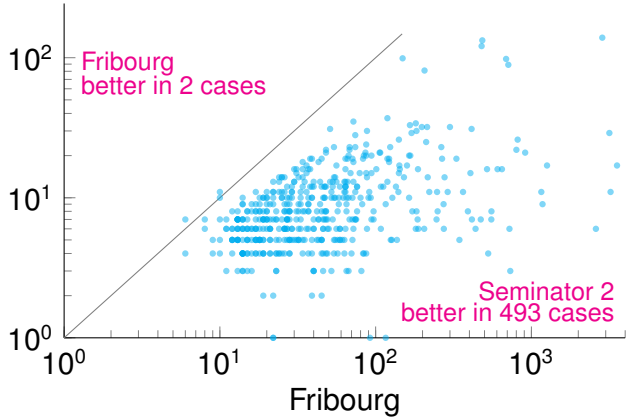

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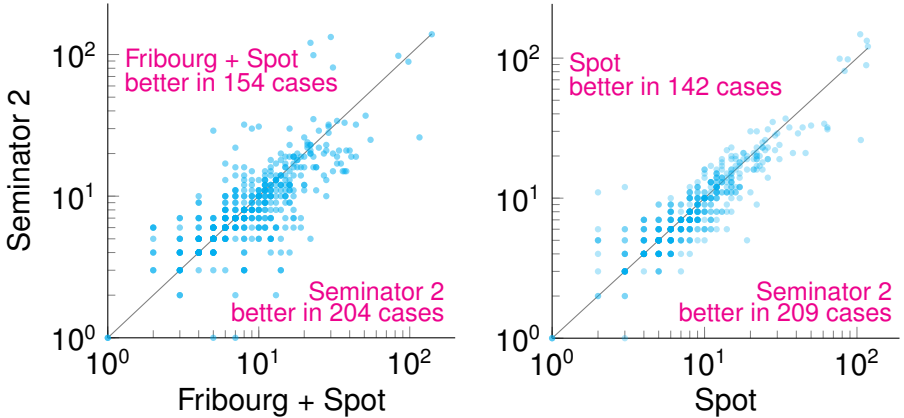

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Availability

Seminator 2 — Source code for the tool
`https://github.com/mklokocka/seminator`

Experimental Evaluation — Scripts for benchmarking and results
(Many more details than covered in the paper or here.)
`https://github.com/xblahoud/seminator-evaluation`

Artifact — Docker image with all tools and evaluation scripts
`https://hub.docker.com/r/gadl/seminator`