Effective Translation of LTL to Deterministic Rabin Automata: Beyond the (F,G)-Fragment

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Highlights 2013

Motivation

- well studied
- efficient tools: SPOT, LTL2BA, LTL3BA,...
- produces nondeterministic Büchi automata

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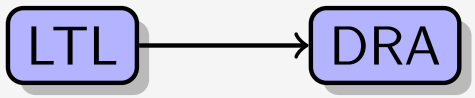
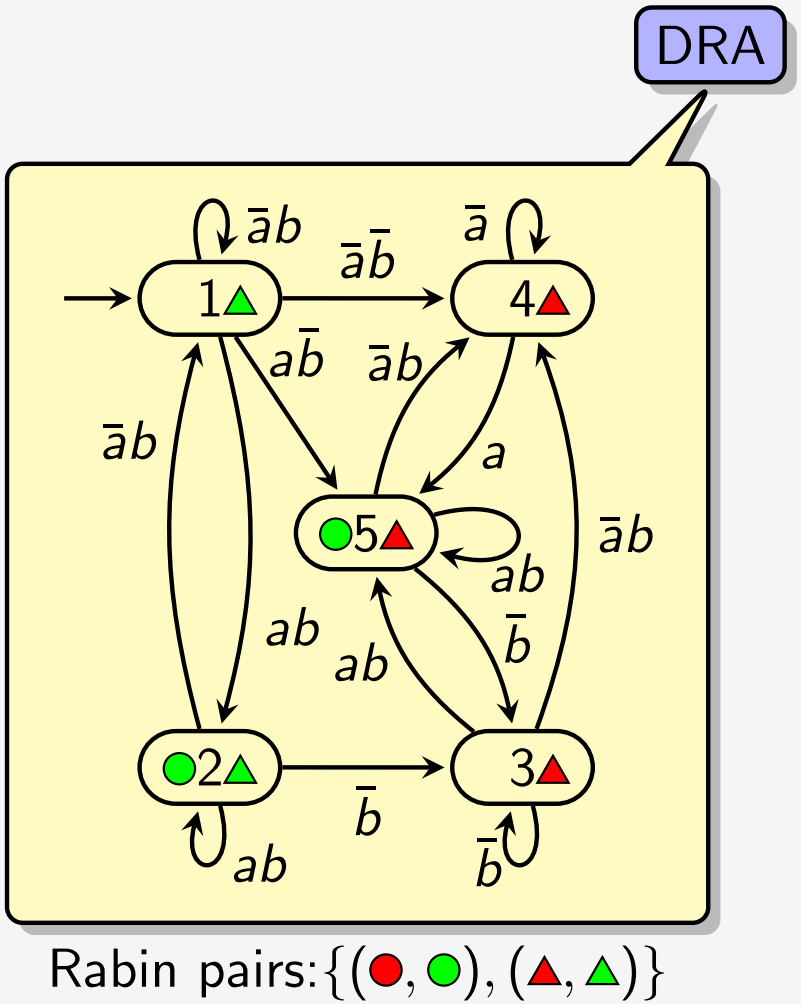


The Big Picture

LTL

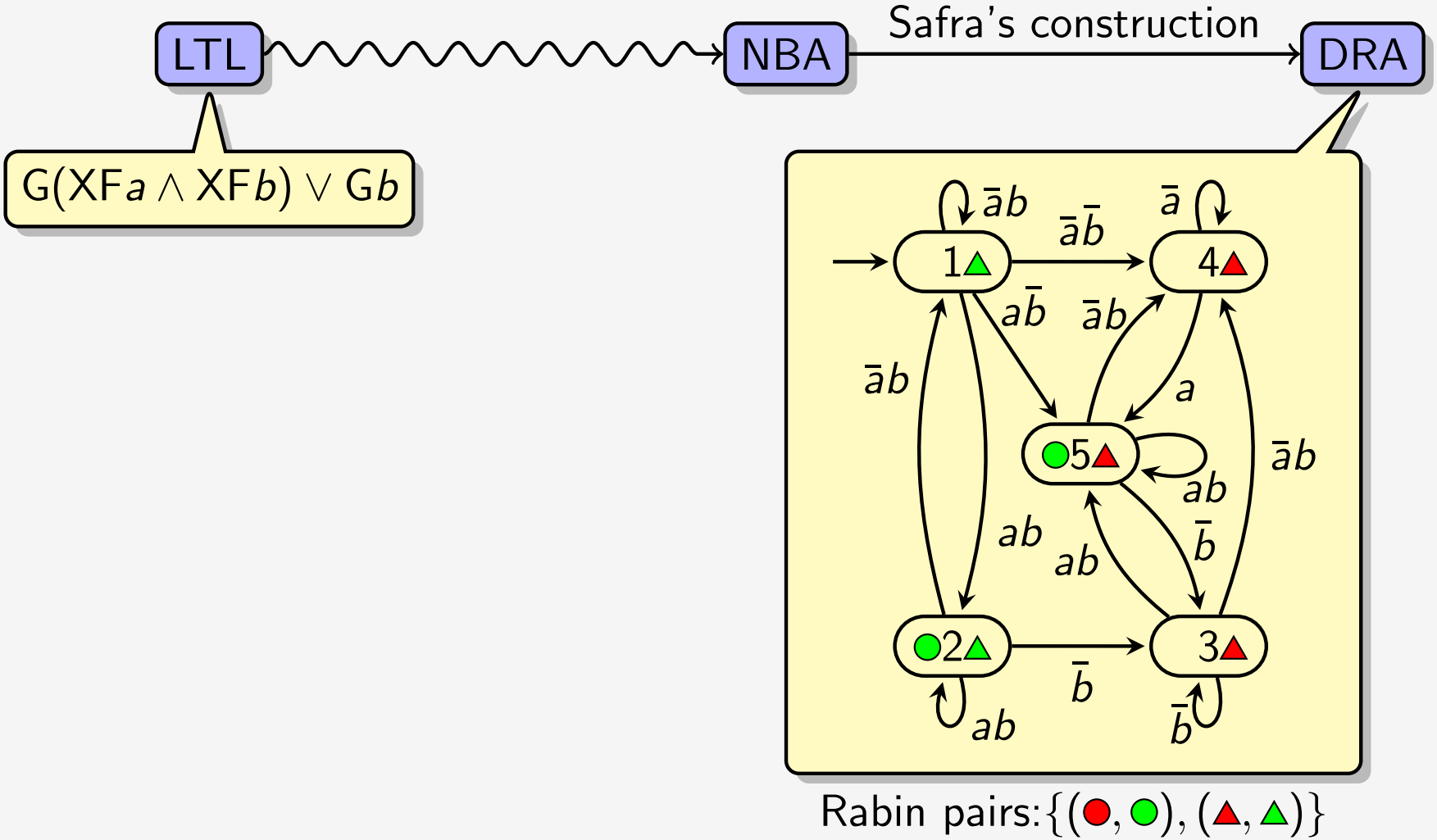
$\mathsf{G}(\mathsf{XF}a \wedge \mathsf{XF}b) \vee \mathsf{G}b$



Rabin pairs: $\{(\bullet, \bullet), (\blacktriangle, \blacktriangle)\}$

The Big Picture

- Typical workflow – `ltl2dstar` [Klein2005]



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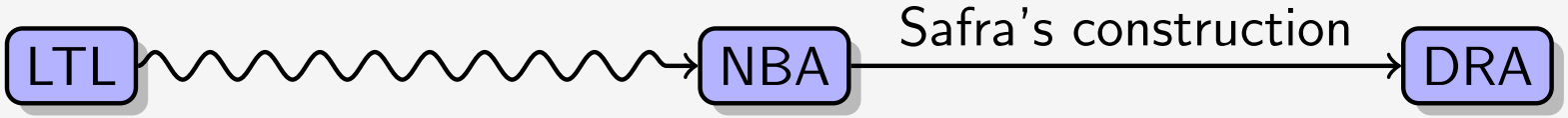

- Rabinizer [Gaiser-J. Křetínský-Esparza2012]

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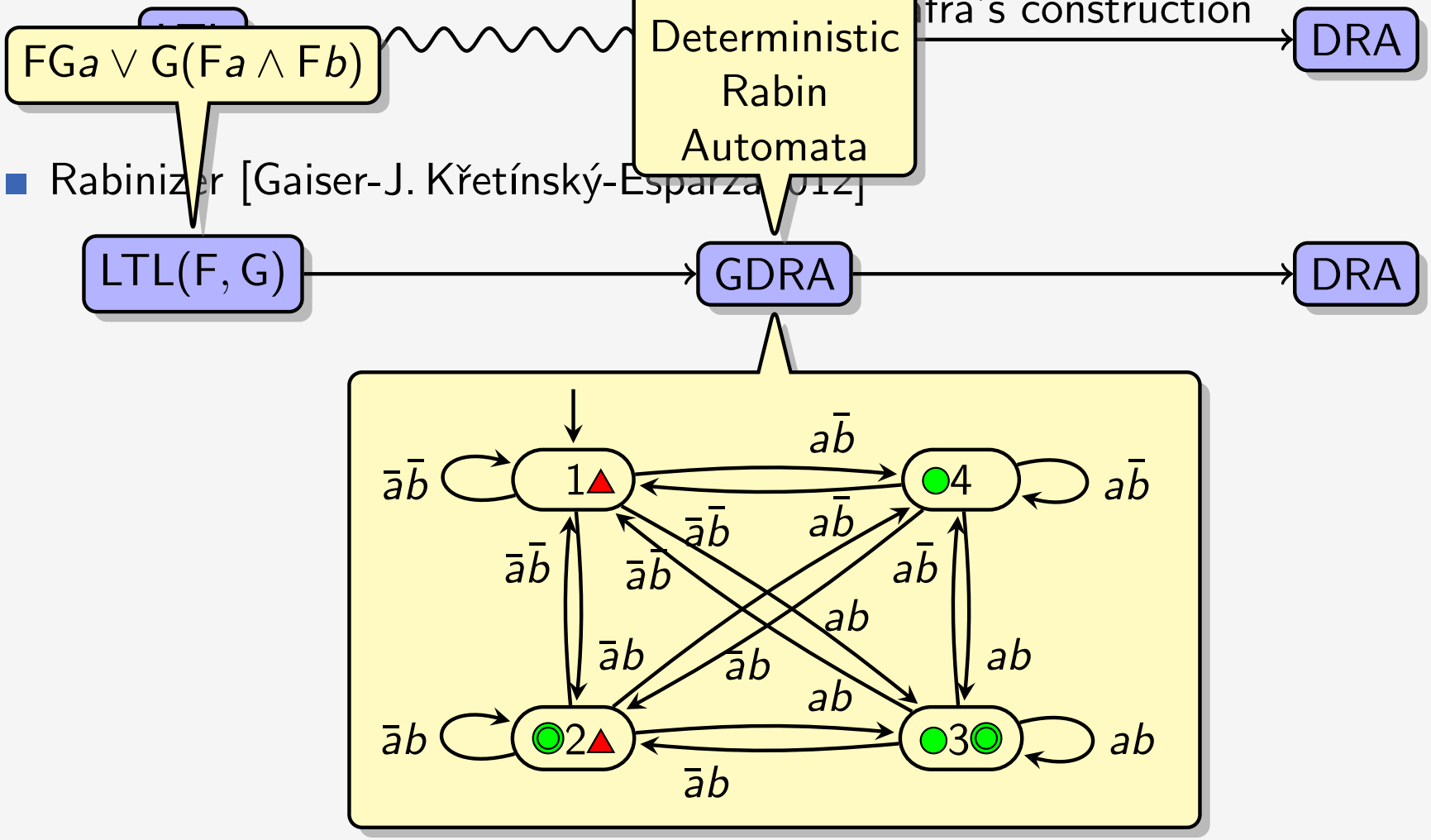

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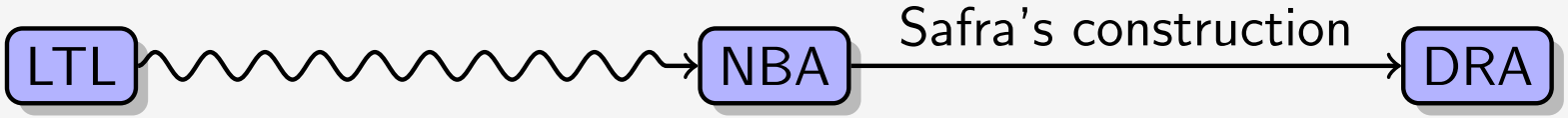

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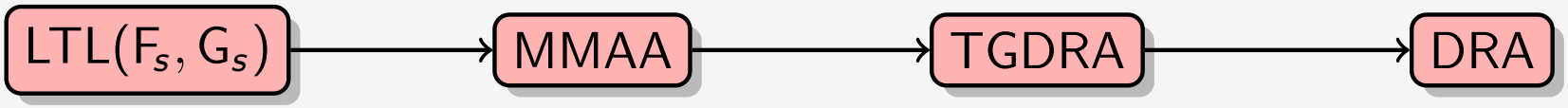
- LTL3DRA [ATVA 2013]



The Big Picture

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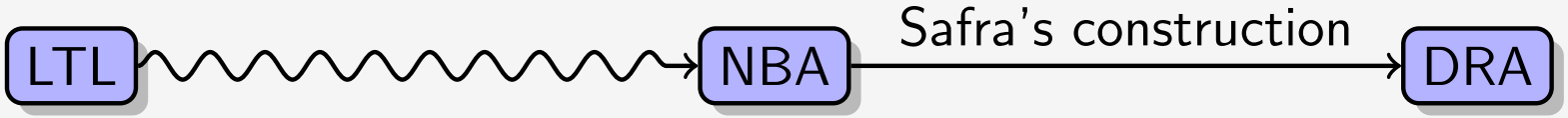

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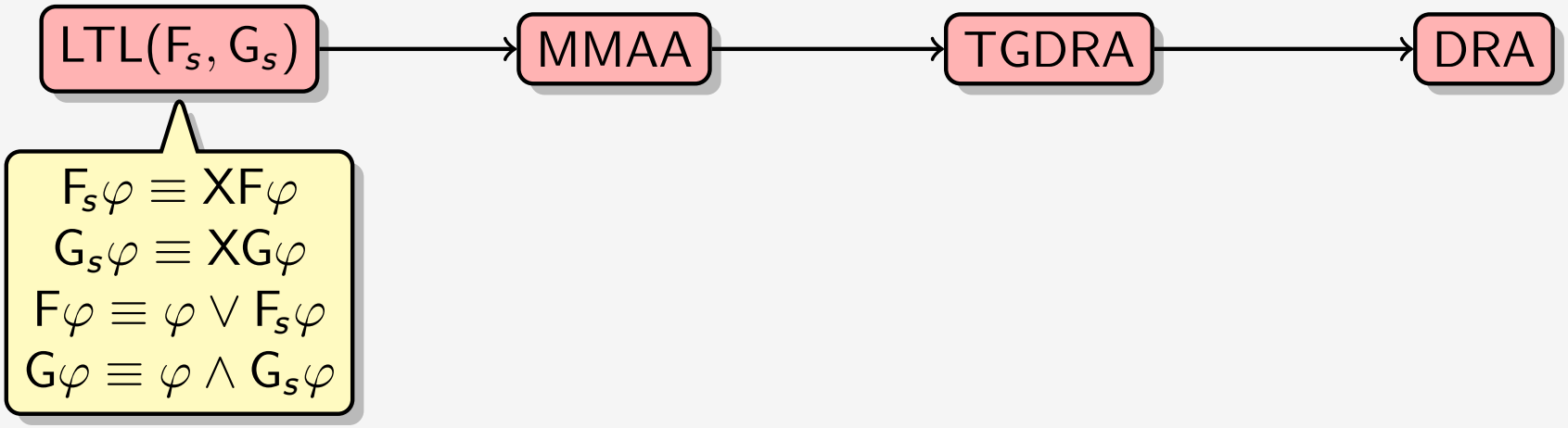

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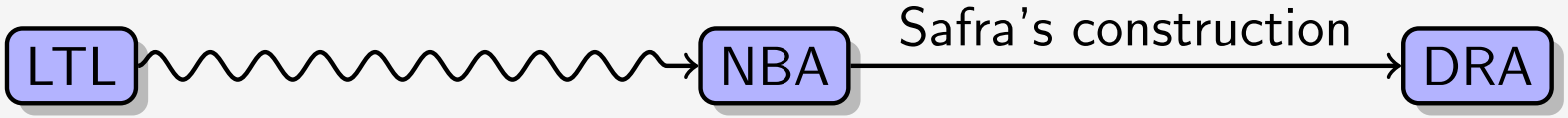

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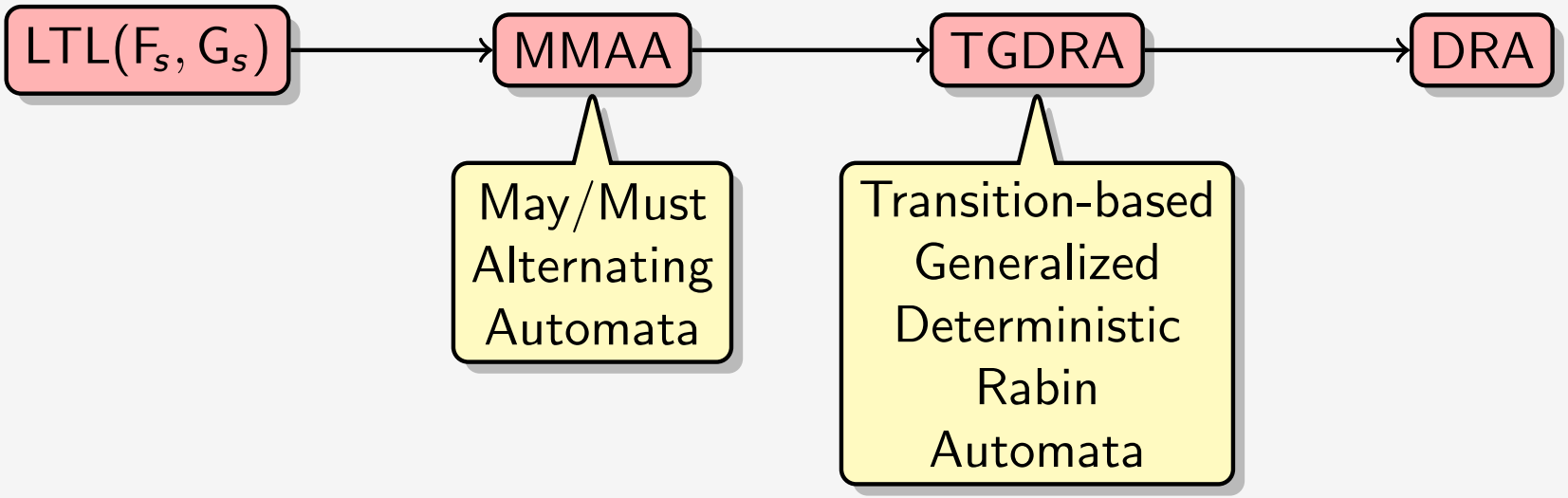

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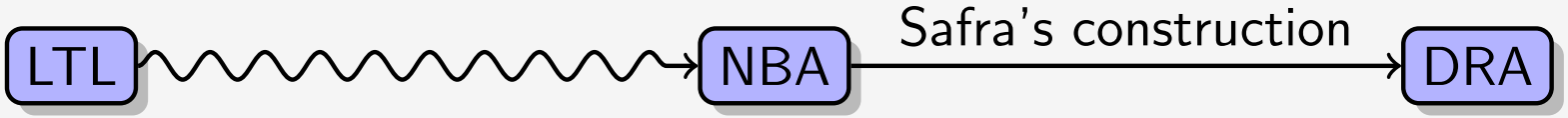

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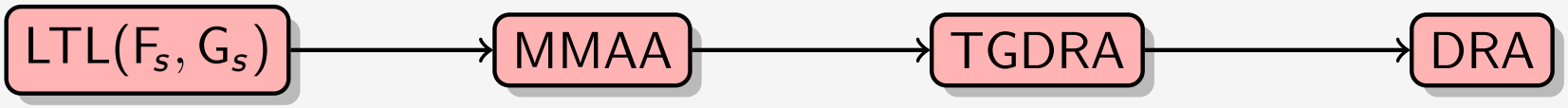
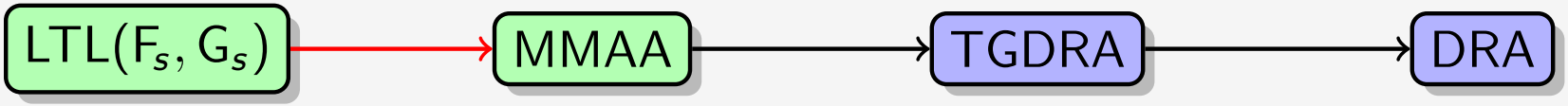
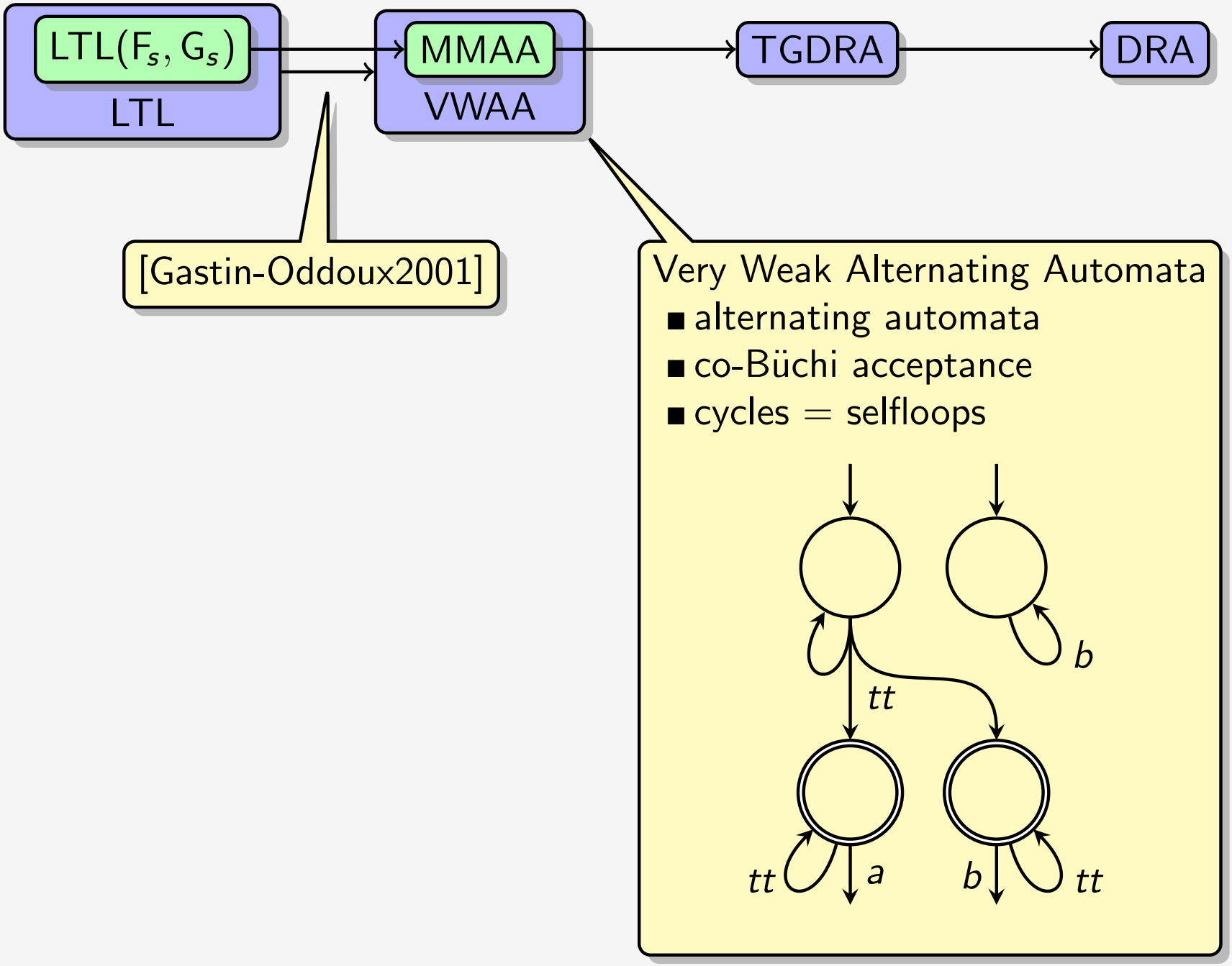
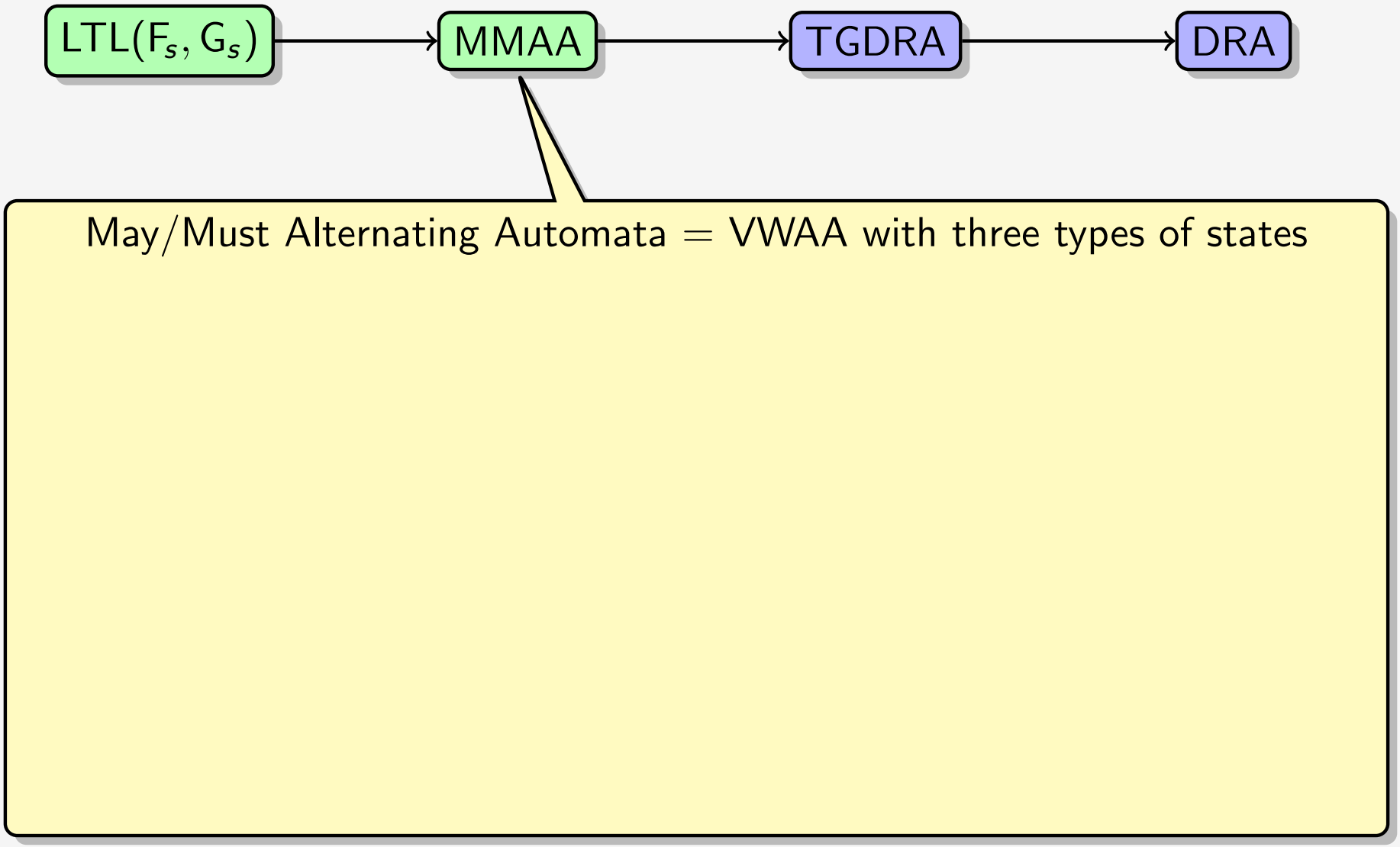


- Rabinizer 2 [J. Křetínský-Ledesma-Garza2013]


LTL(F_s, G_s)
MMAA
TGDRA
DRA


LTL(F_s, G_s)
LTL
MMAA
VWAA
TGDRA
DRA
[Gastin-Oddoux2001]
Very Weak Alternating Automata
alternating automata
co-Büchi acceptance
cycles = selfloops
b
tt
tt
a
b
tt


LTL(F_s, G_s)
MMAA
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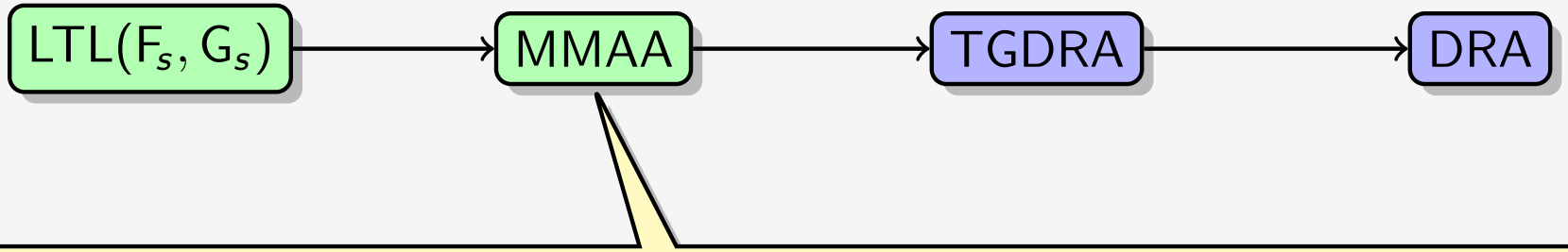
May/Must Alternating Automata = VWAA with three types of states

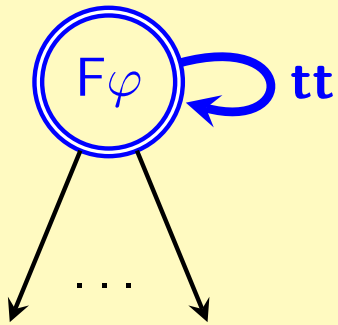


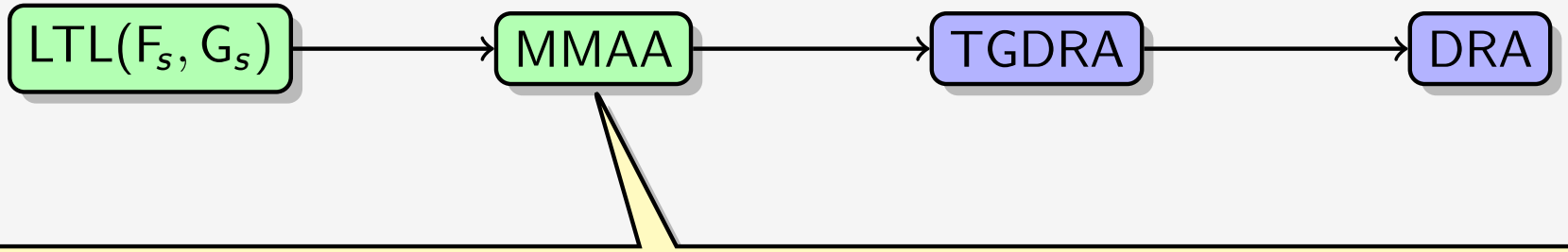
May/Must Alternating Automata = VWAA with three types of states

May

selfloop under *tt*

co-Büchi accepting

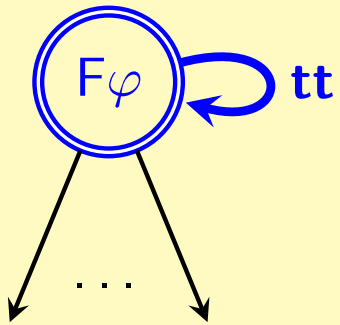


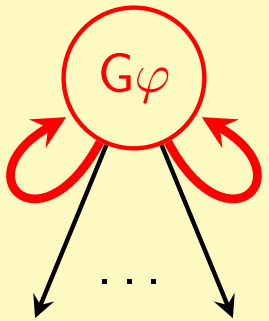


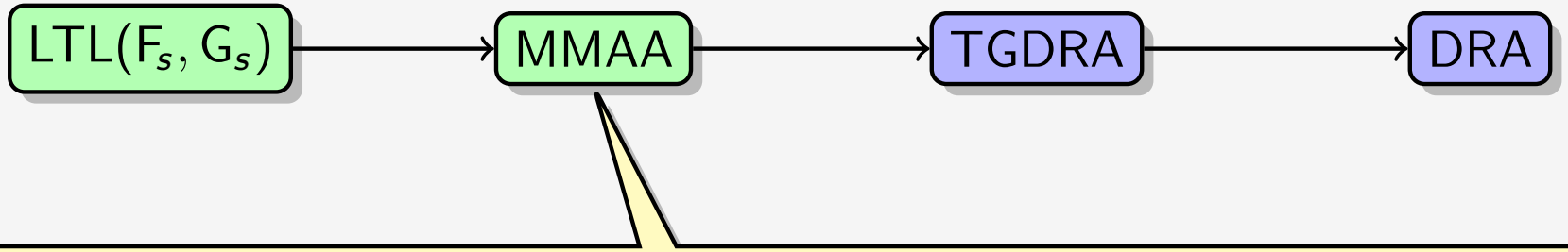
May/Must Alternating Automata = VWAA with three types of states

May
selfloop under *tt*
co-Büchi accepting

Must
selfloop in each transition
co-Büchi nonaccepting







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selfloop under *tt*
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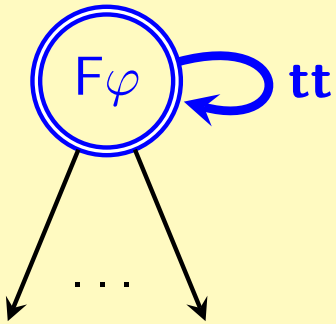

Must
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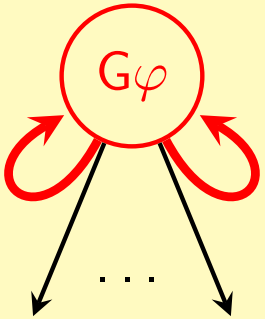
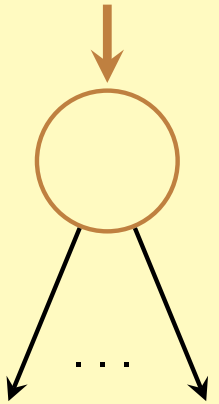
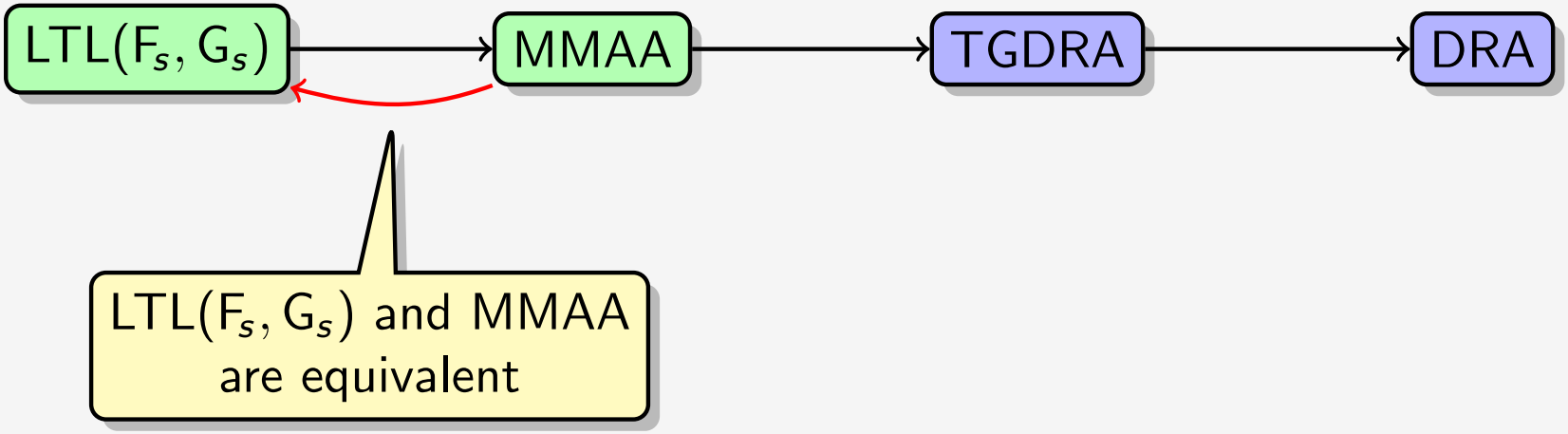
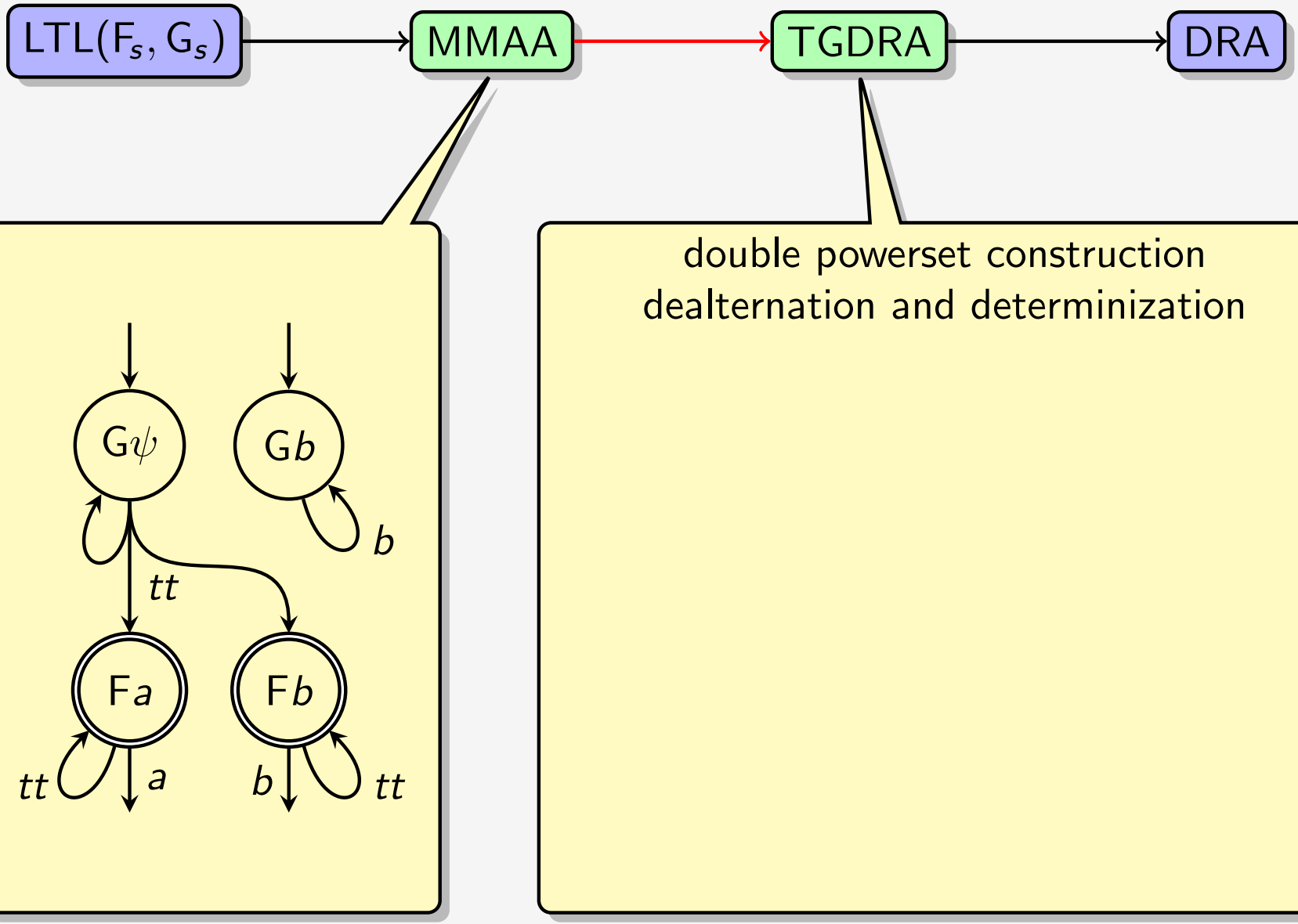
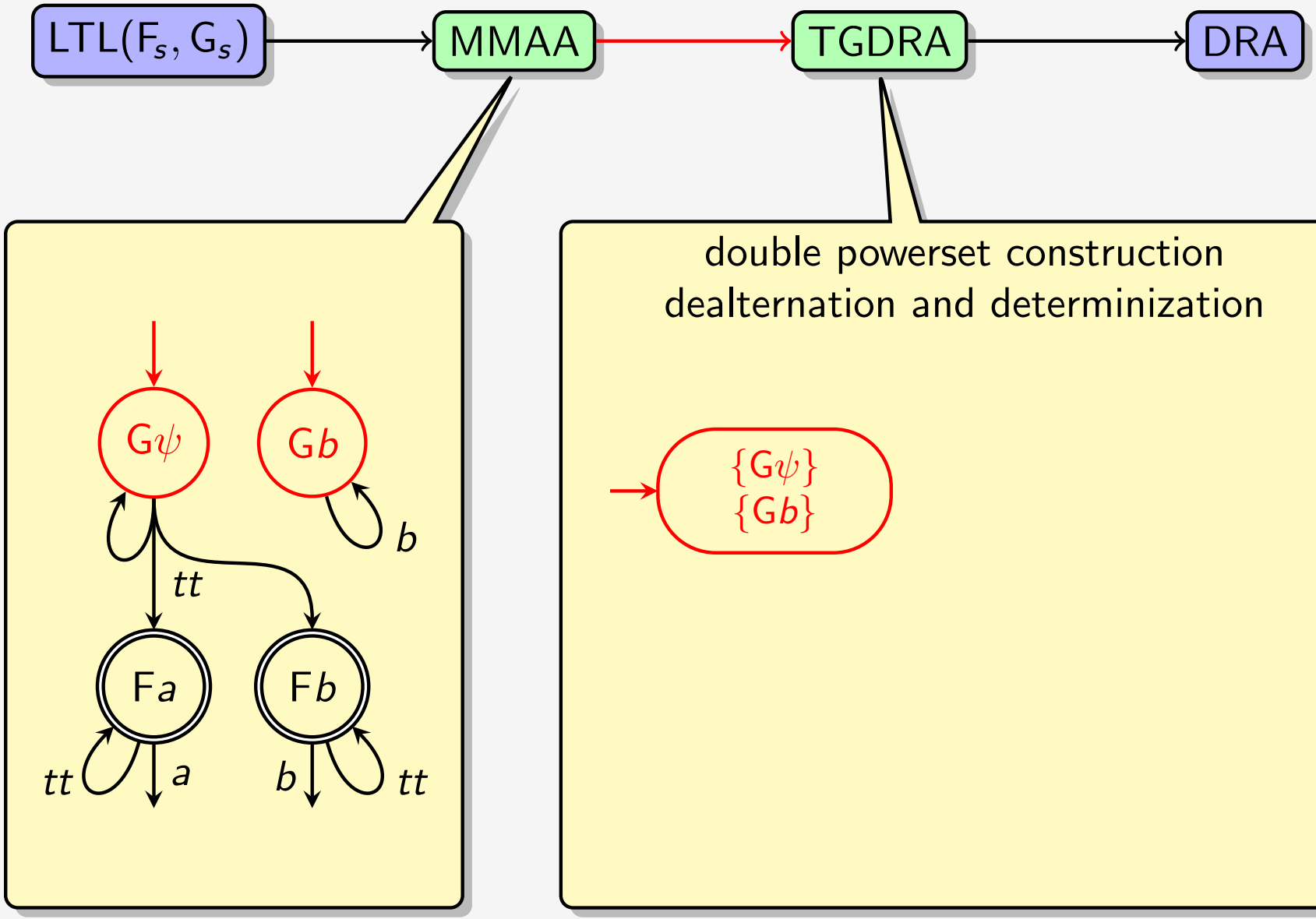


Loopless
initial
no predecessors




LTL(F_s, G_s)
MMAA
TGDRA
DRA
LTL(F_s, G_s) and MMAA are equivalent


LTL(F_s, G_s)
MMAA
TGDRA
DRA
Gψ
Gb
b
tt
Fa
Fb
tt
a
b
tt
double powerset construction
dealternation and determinization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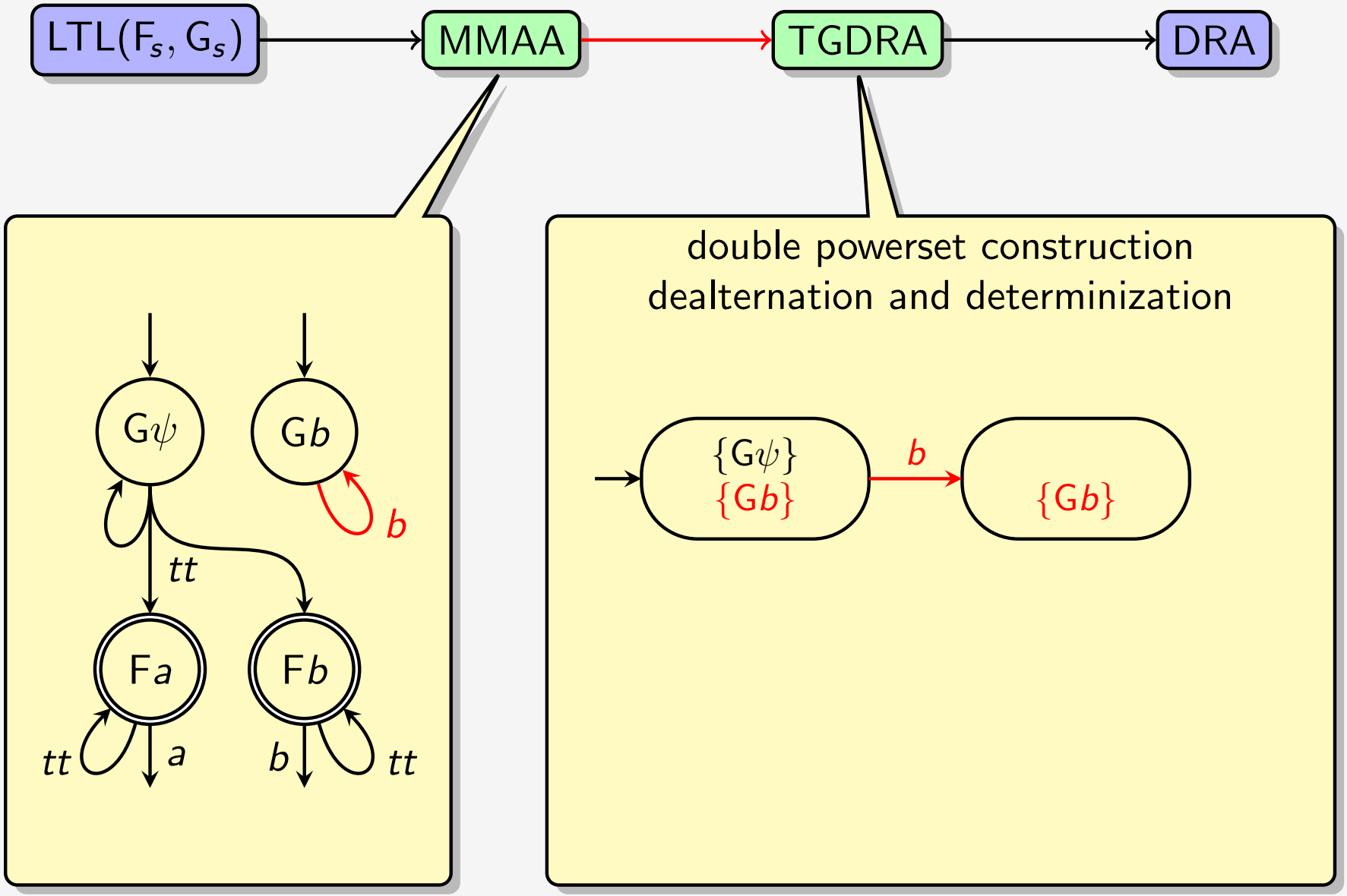
{Gψ}
{Gb}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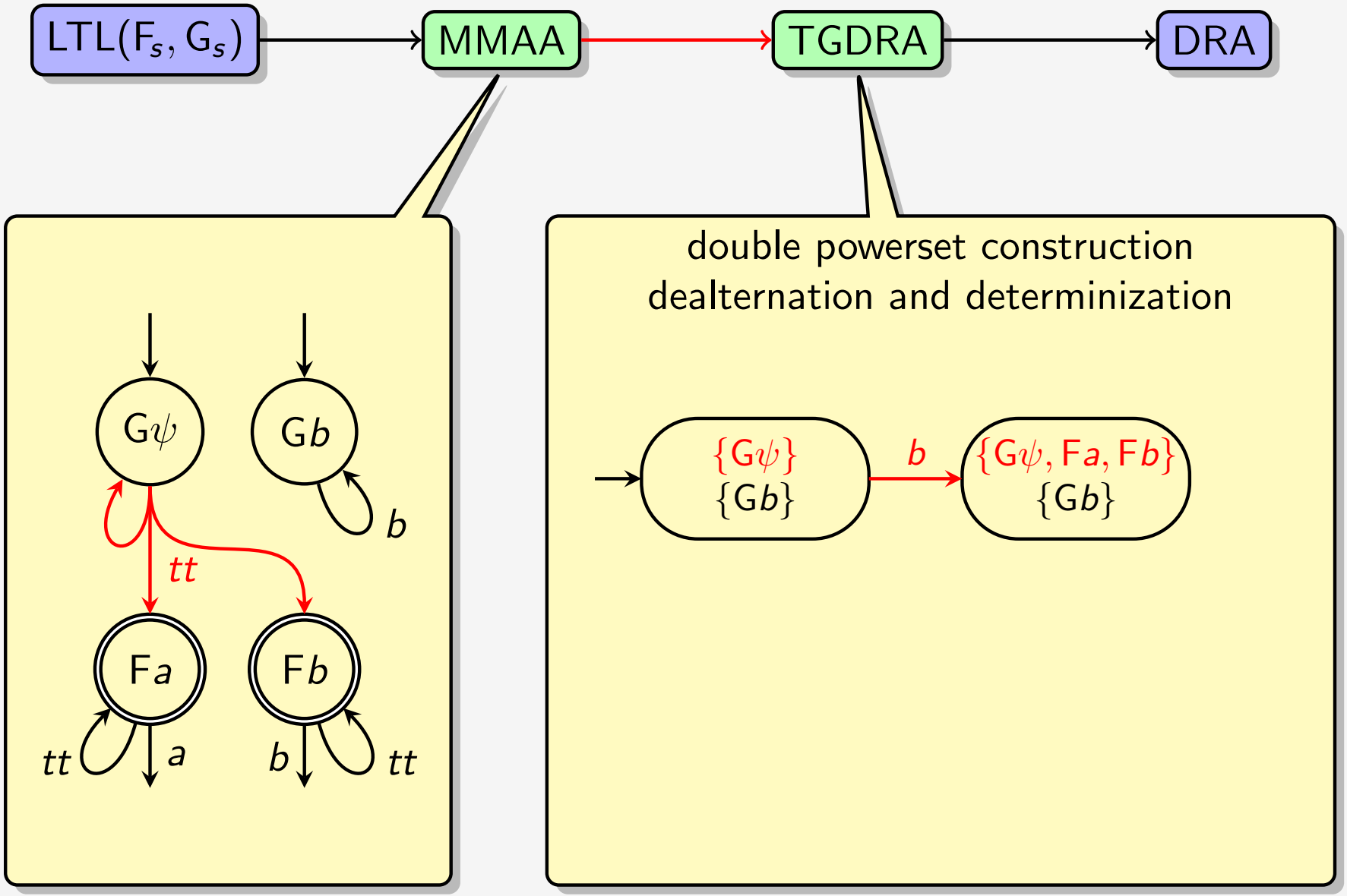
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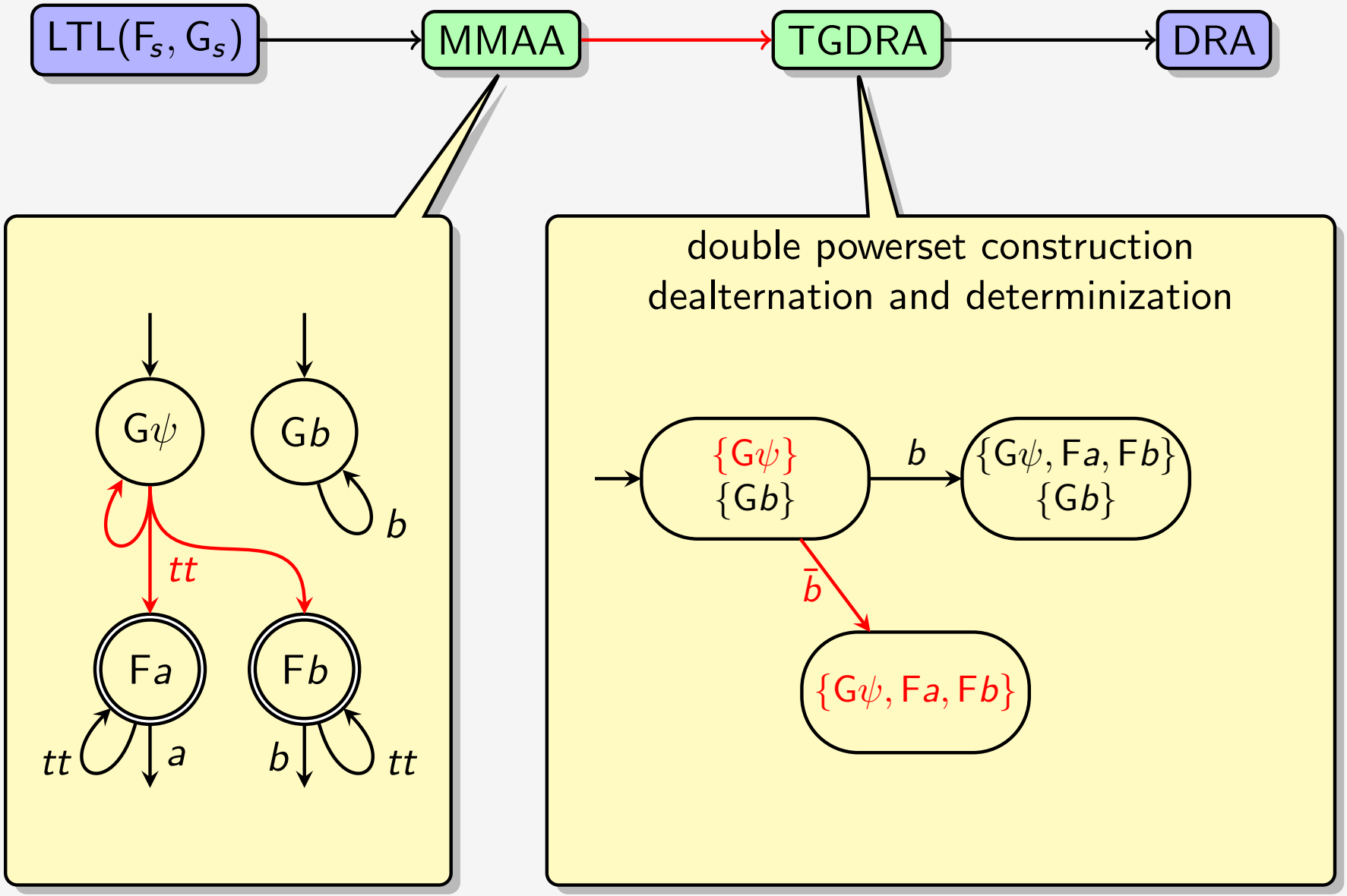
{Gψ}
{Gb}
b
{Gψ, Fa, Fb}
{Gb}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Gψ
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double powerset construction
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{Gψ}
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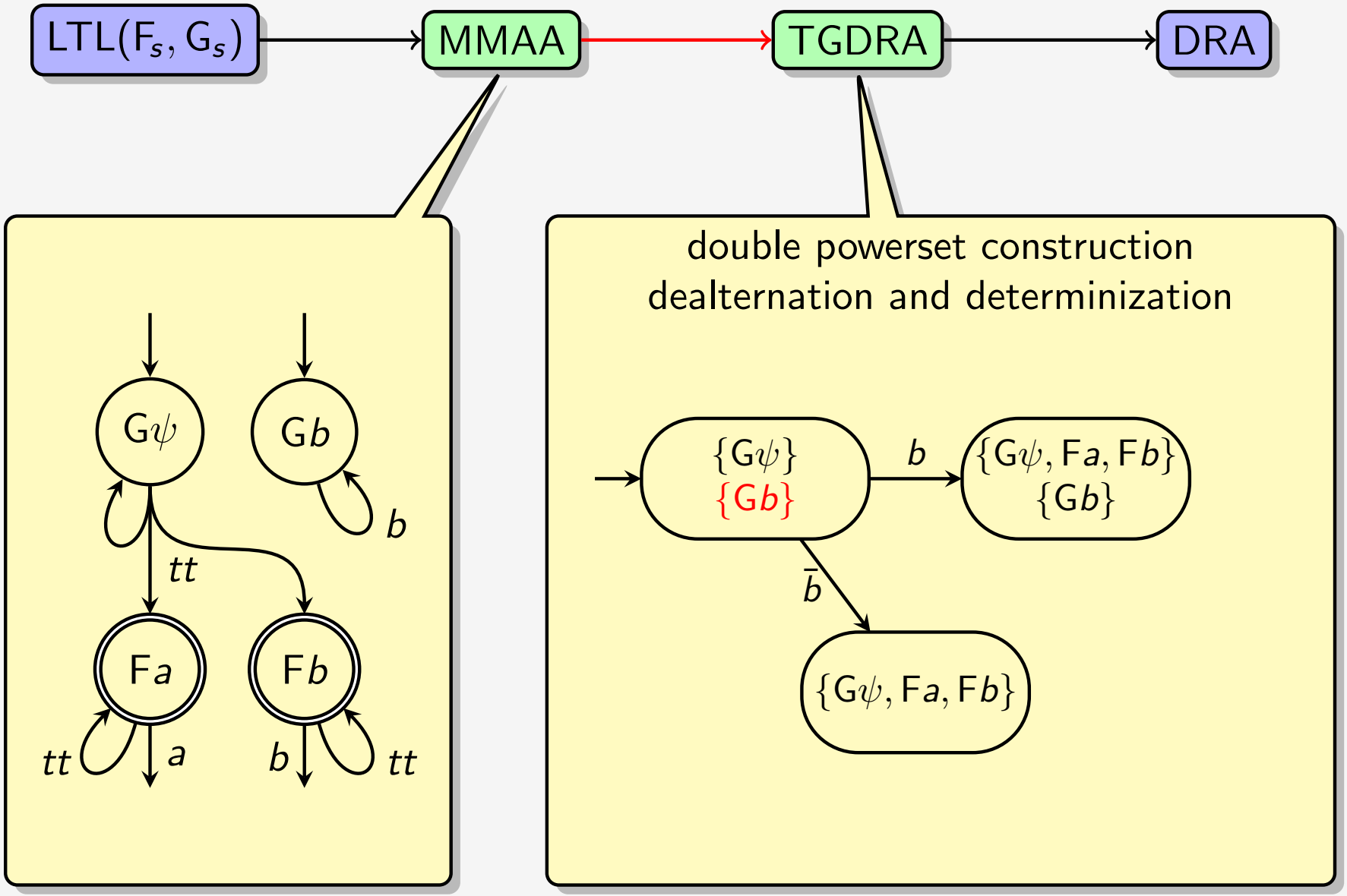
b
{Gψ, Fa, Fb}
{Gb}
$\bar{b}$
{Gψ, Fa, Fb}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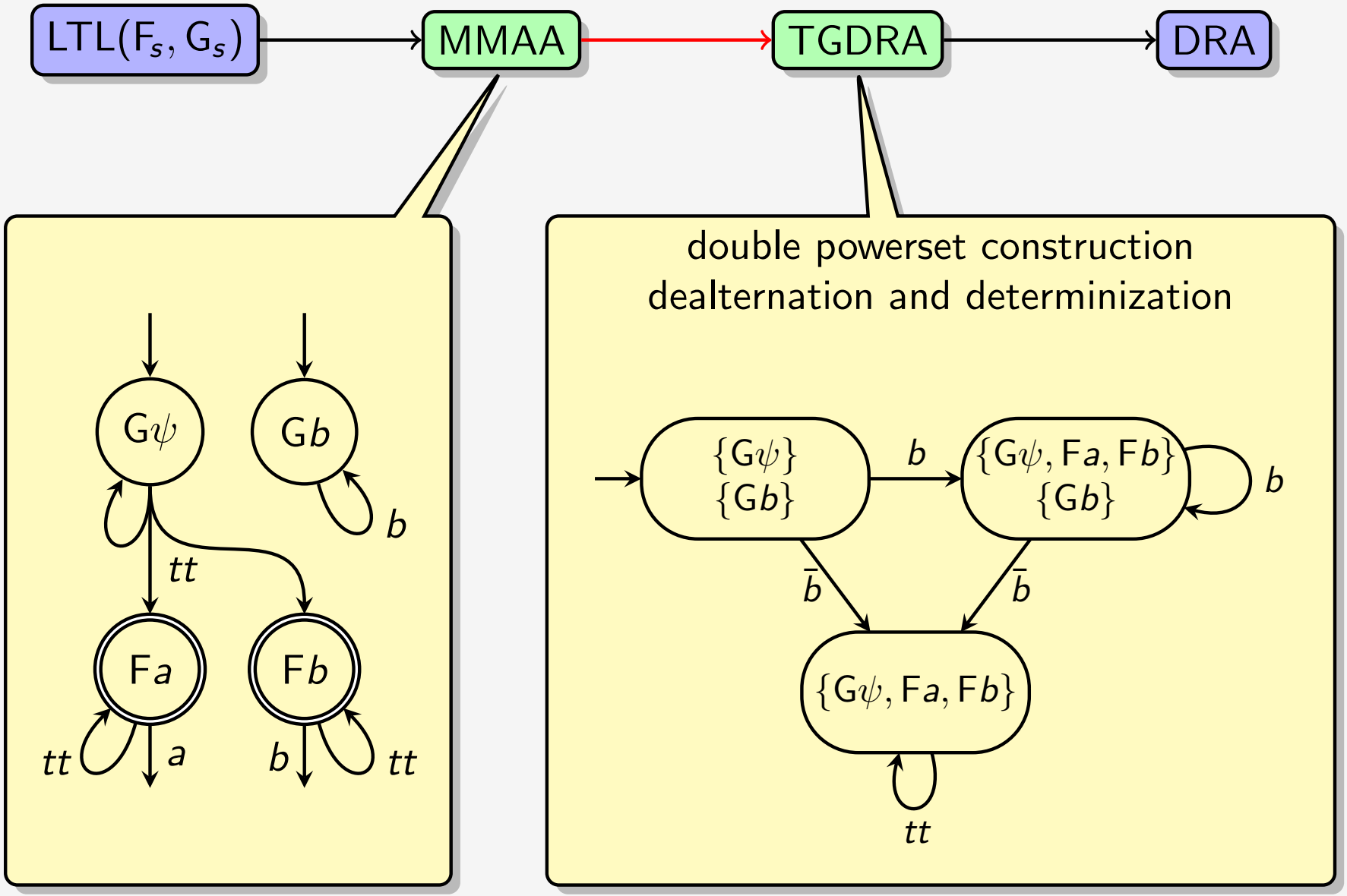
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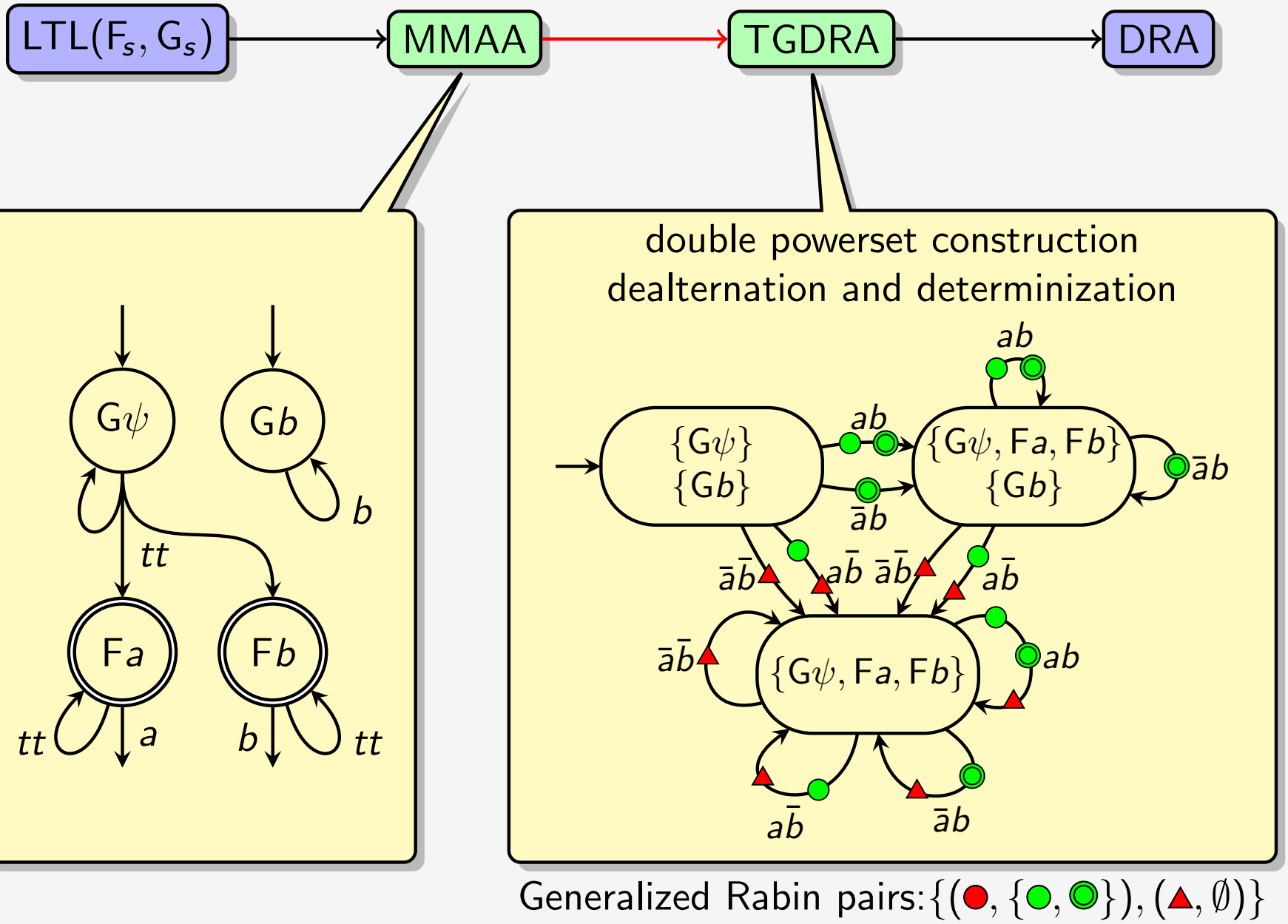
tt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tt
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ab
{Gψ}
{Gb}
ab
$\bar{a}b$
{Gψ, Fa, Fb}
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$\bar{a}\bar{b}$
$a\bar{b}$
$\bar{a}\bar{b}$
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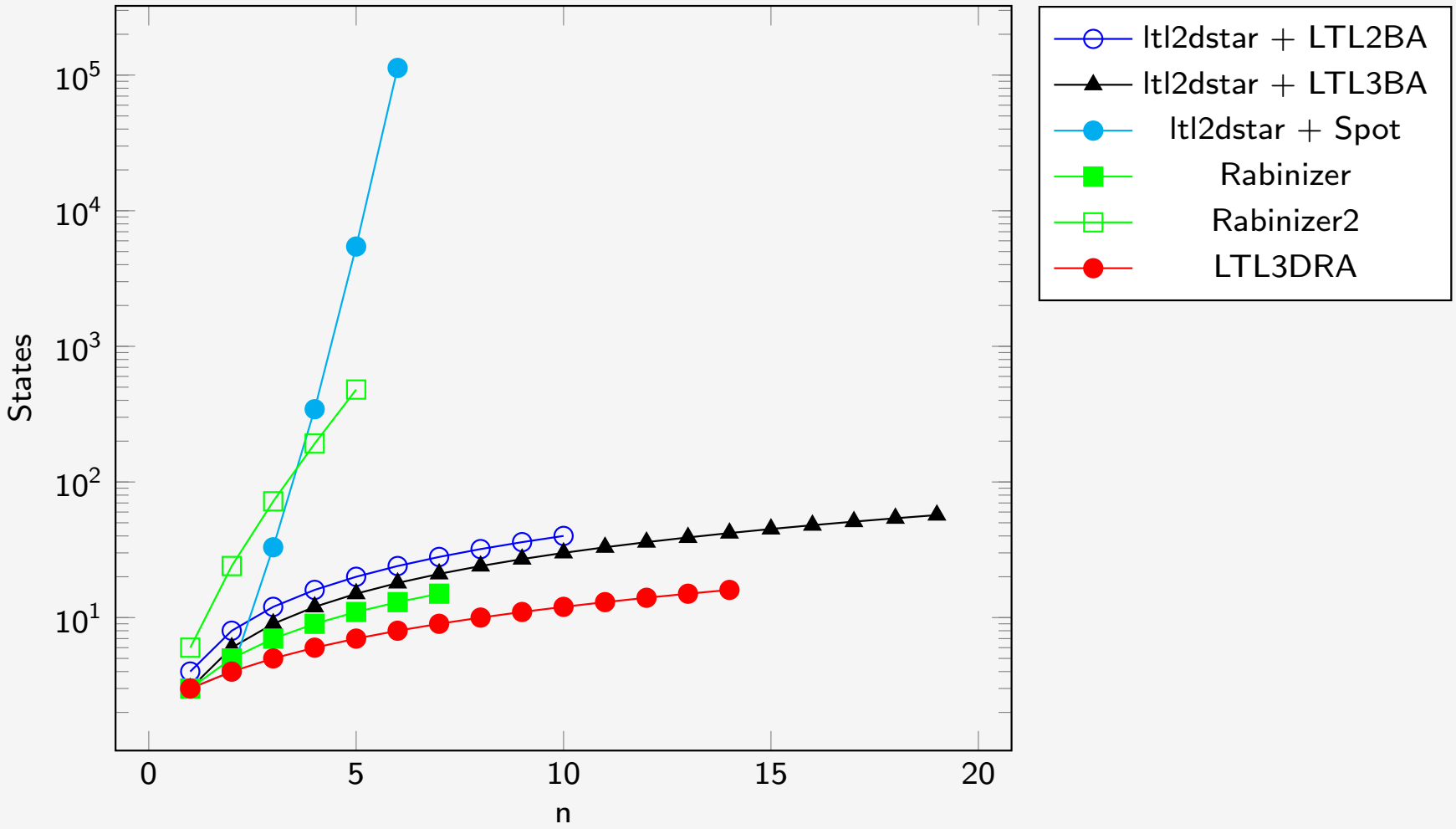
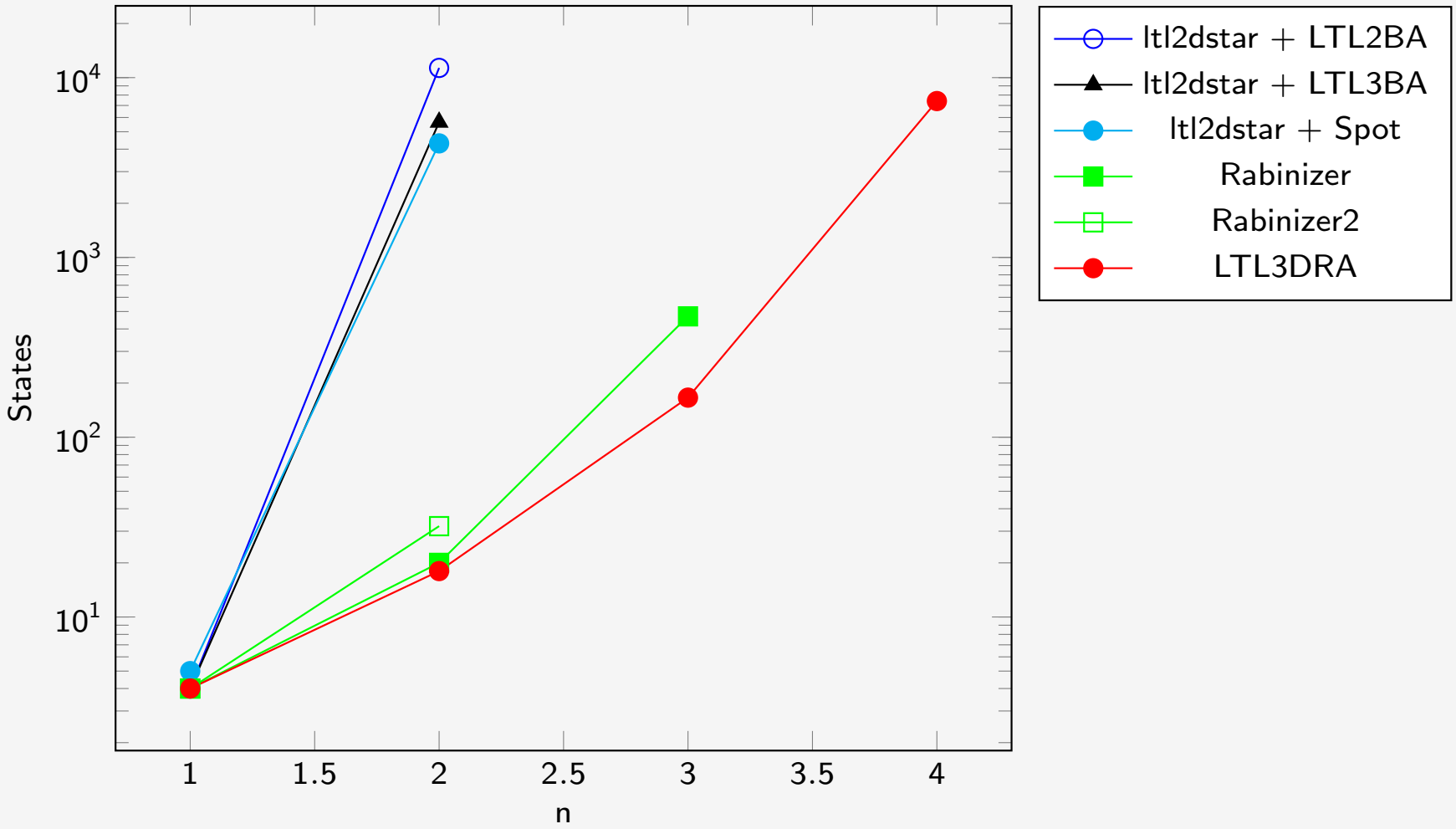
{Gψ, Fa, Fb}
ab
$a\bar{b}$
$\bar{a}b$
Generalized Rabin pairs: {(●, {●, ◉}), (▲, ∅)}

Experiments on parametric formulae



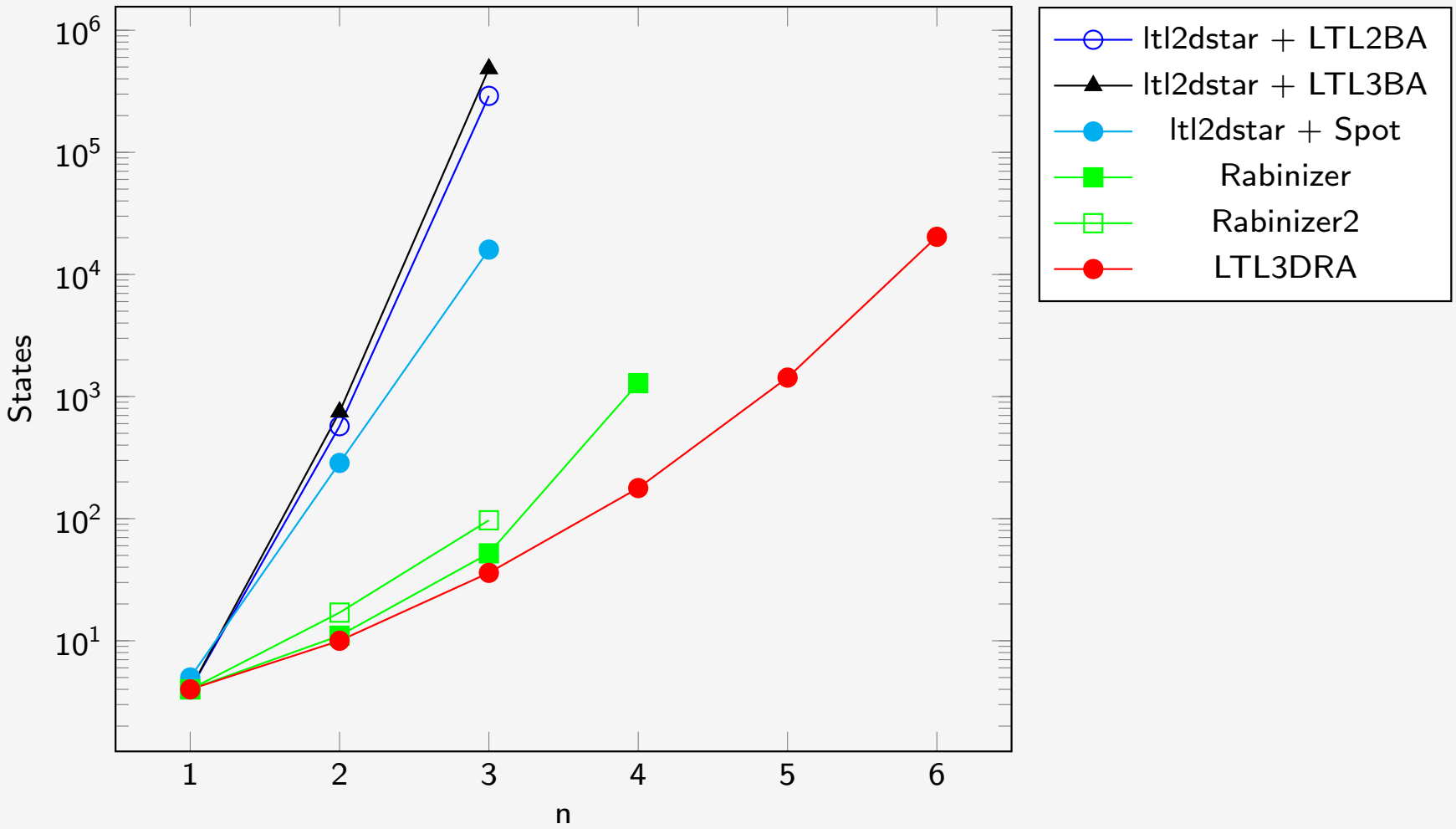
$$\theta(n) = \neg((\bigwedge_{i=1}^{n} \mathsf{GF}p_i) \rightarrow \mathsf{G}(q \rightarrow \mathsf{F}r))$$

Experiments on parametric formulae



$$F(n) = \bigwedge_{i=1}^{n} (\mathrm{GF} p_i \rightarrow \mathrm{GF} q_i)$$

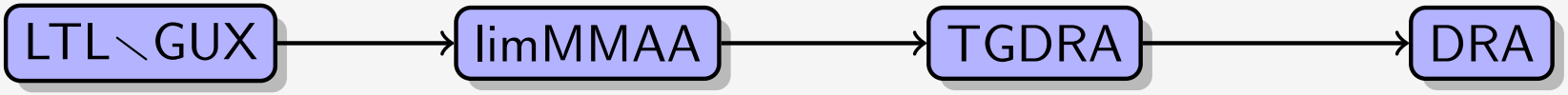
Experiments on parametric formulae



$$R(n) = \bigwedge_{i=1}^{n} (\mathsf{GF} p_i \vee \mathsf{FG} p_{i+1})$$

Concluding remarks

- Extended translation



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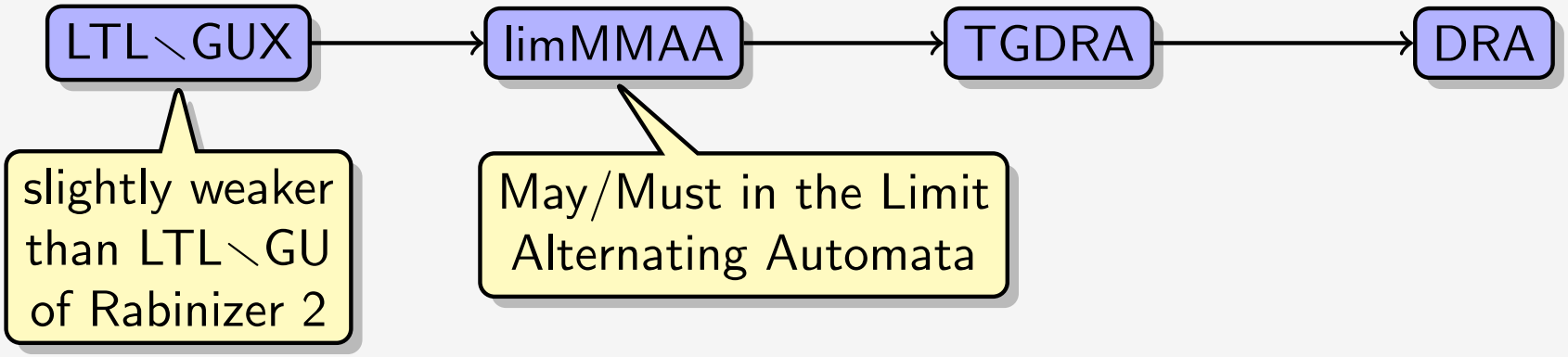

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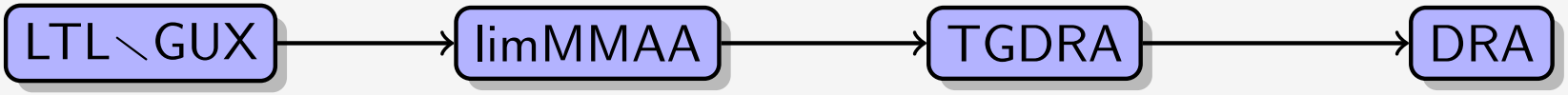

- LTL3DRA available at http://sourceforge.net/projects/ltl3dra/
- experimental comparison of LTL to DRA translators submitted to LPAR'13

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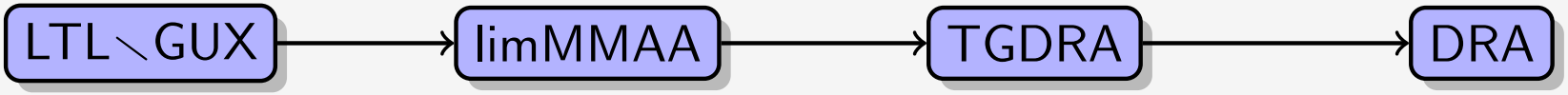
- Extended translation



- LTL3DRA available at `http://sourceforge.net/projects/ltl3dra/`
- experimental comparison of LTL to DRA translators submitted to LPAR'13

New tools are appearing, but only `ltl2dstar` can handle the whole LTL. Yet?