Proving Java Termination: Reducing the Ugly to the Bad

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Automated Termination Analysis

Imperative Programs:

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Imperative Programs:

- Synthesis of Linear Ranking Functions
  (Colon & Sipma, '01), (Podelski & Rybalchenko, '04), . . .

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  KITTeL – (*Falke, Kapur, Sinz*, since '11)
- Termination Analysis for Java (via Path Length, CLP backend)
  Julia – (*Spoto, Mesnard, Payet*, since '08)
  COSTA – (*Albert, Arenas, Codish, Genaim, Puebla, Zanardini*, since '08)

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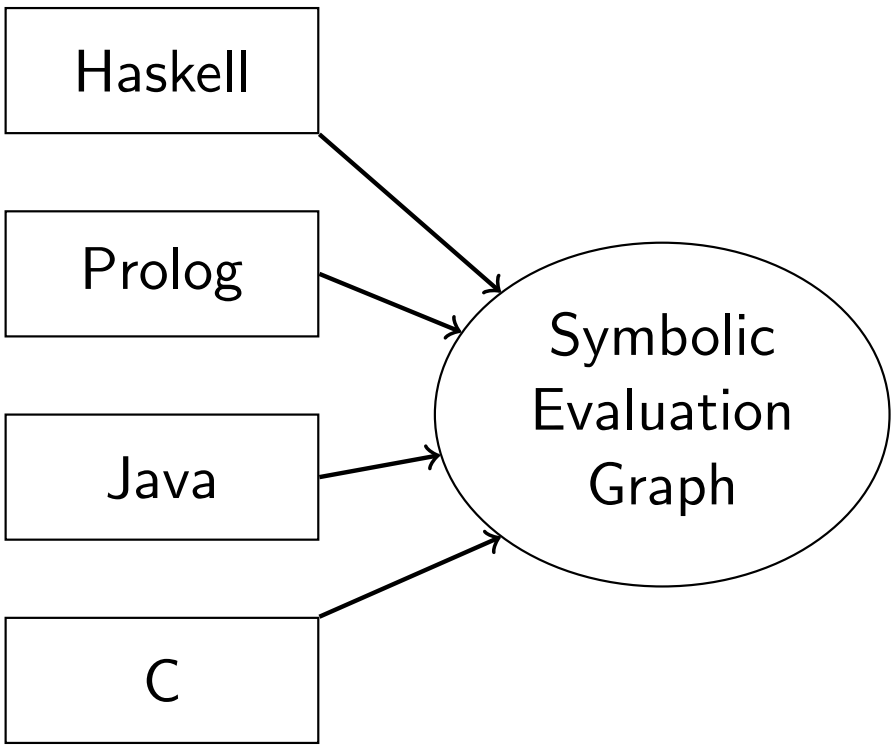

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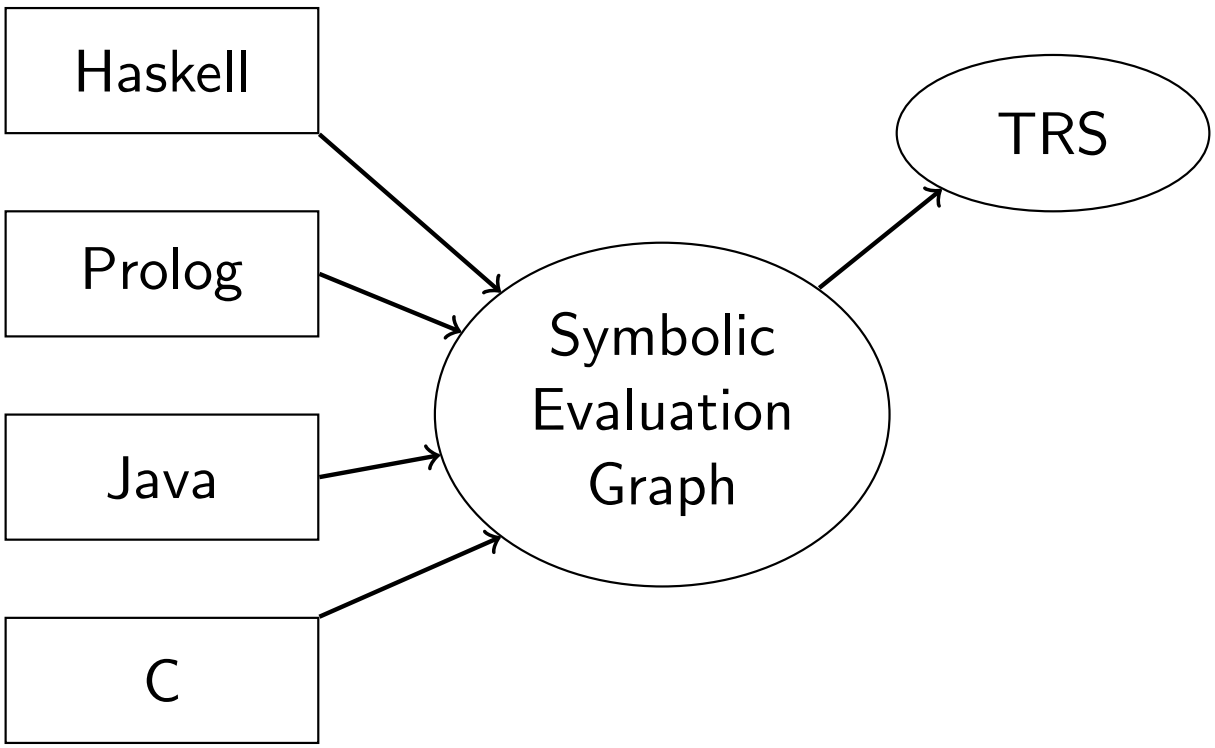

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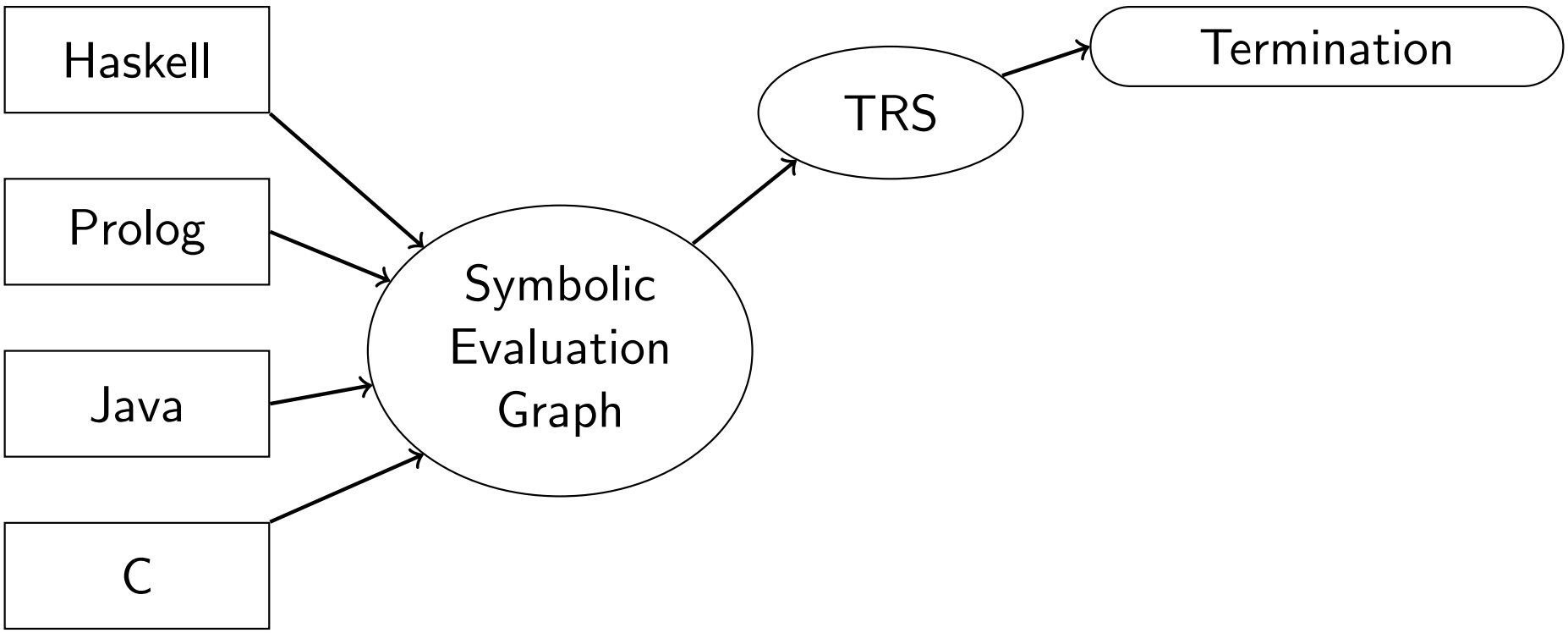

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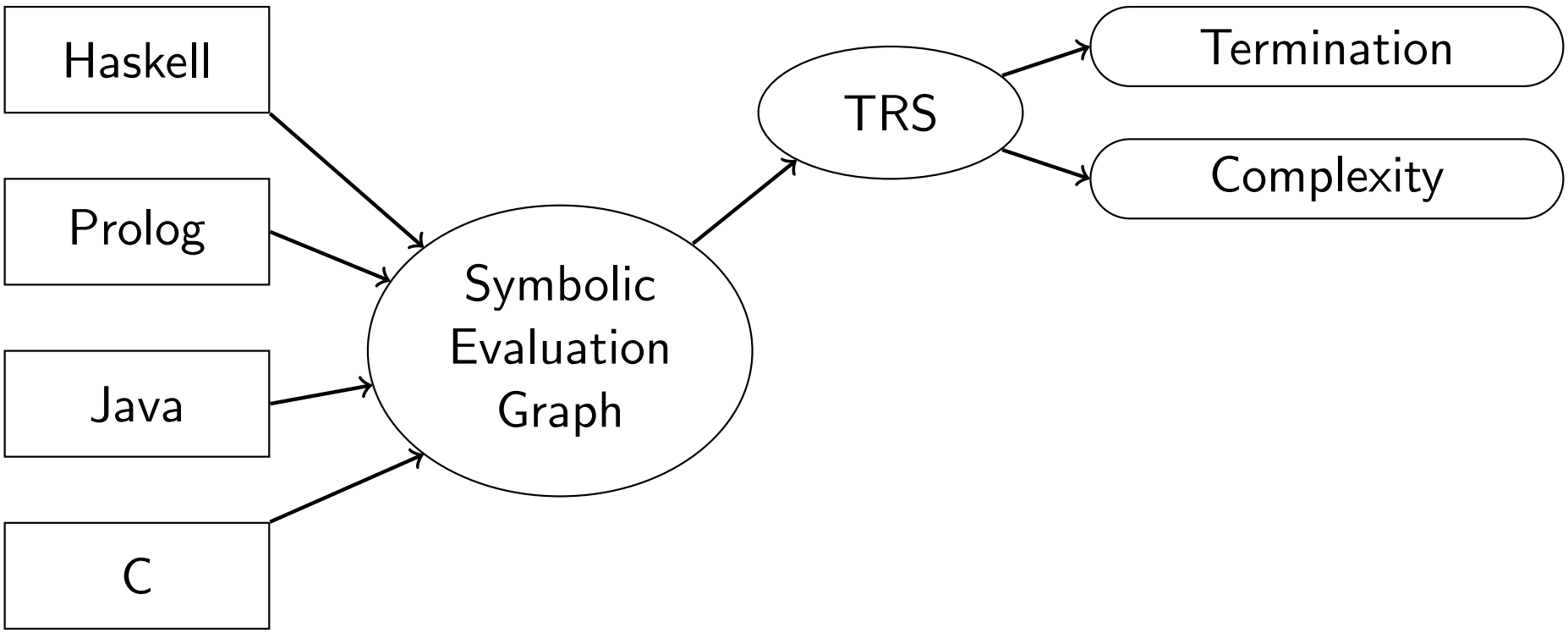

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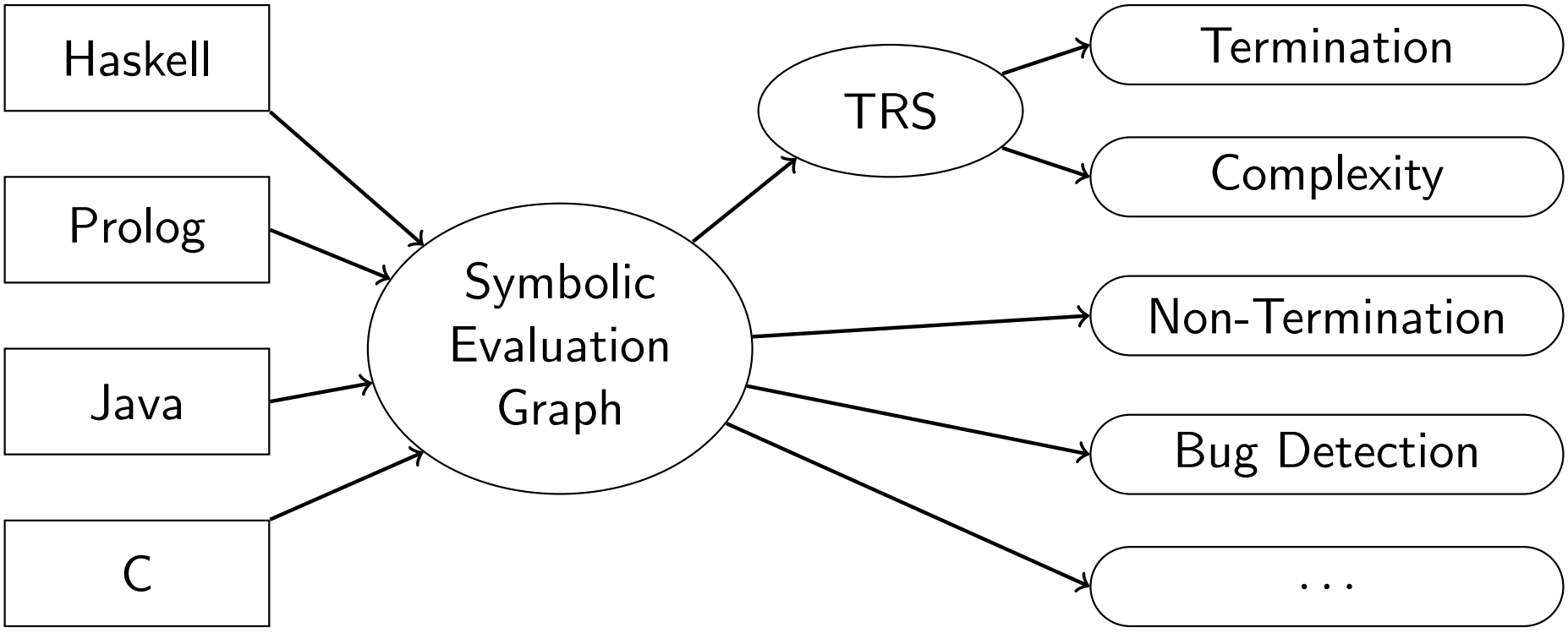

Rewriting-backed approach: Advantages

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- **TRS techniques** search for suitable orders automatically

$\Rightarrow$ Complex orders for user-defined data structures possible

length: the example

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class L {
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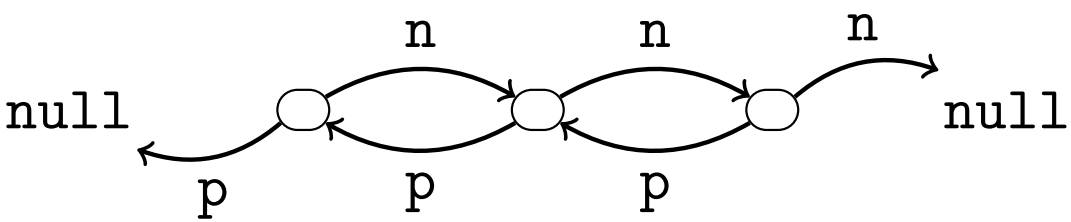

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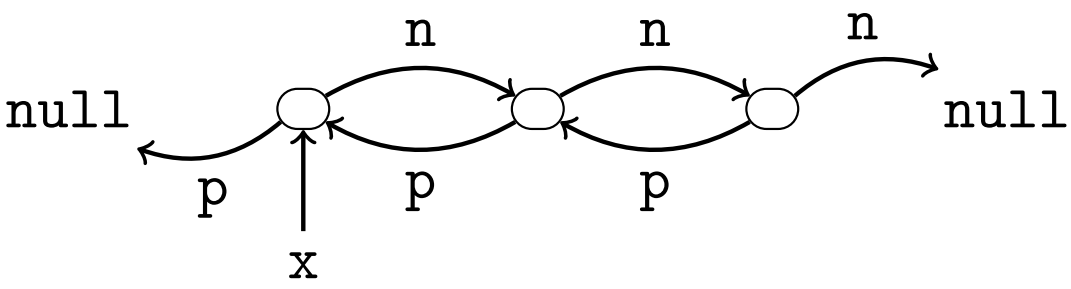

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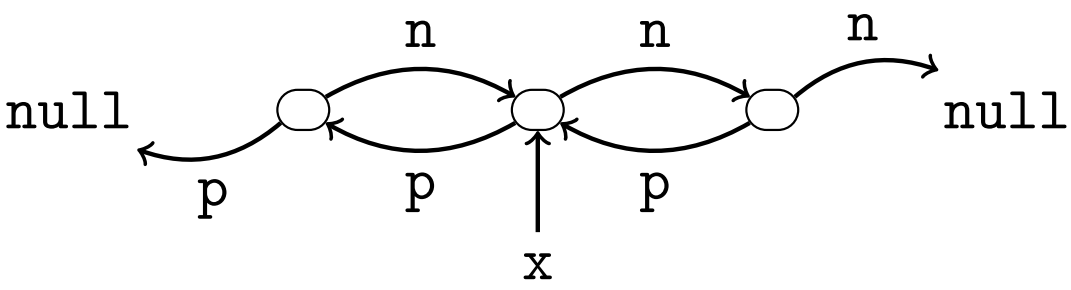

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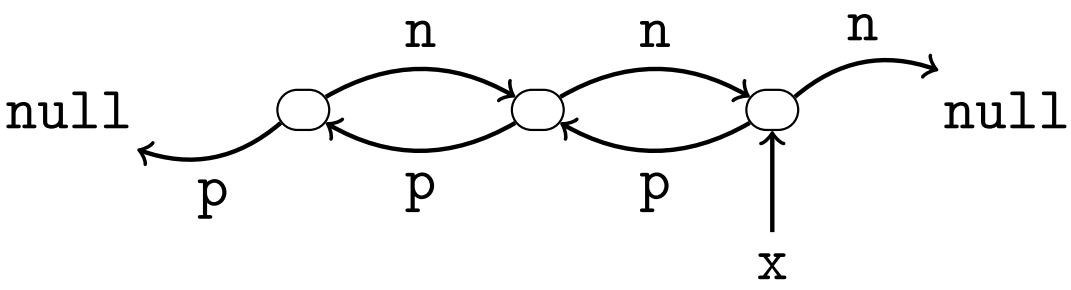

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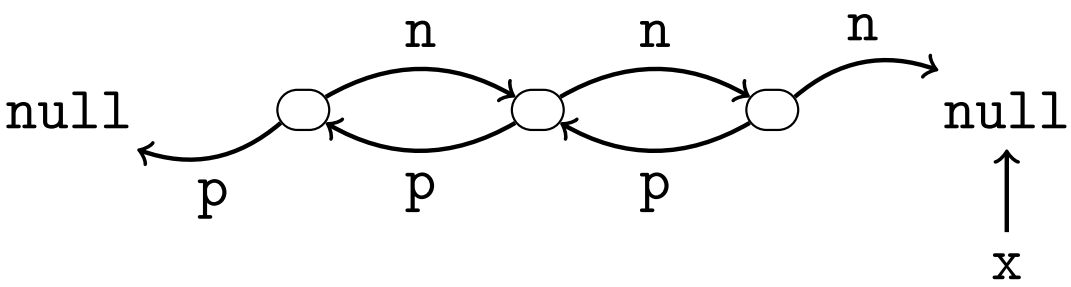

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Stack frame:

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$o_1 : \mathrm{L}(?)$	$o_1 \circlearrowleft_{\{p,n\}}$	

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- Reference might have cycles containing all fields F: $o_1\circlearrowleft_F$

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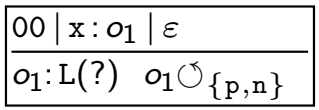

A

State A:

- x some list, might contain cycles using p and n

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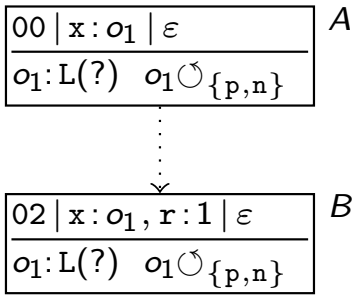

State *A*:

- `x` some list, might contain cycles using `p` and `n`

State *B*:

- Initialized variable `r` to 1

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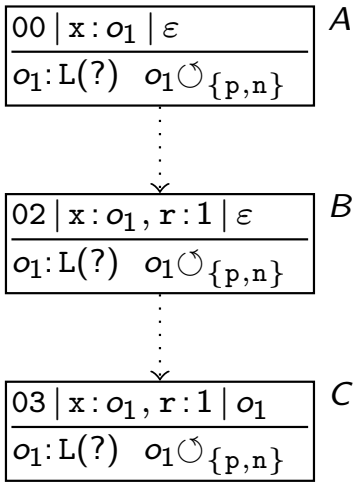

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- `x` (o_1) null? We do not know!

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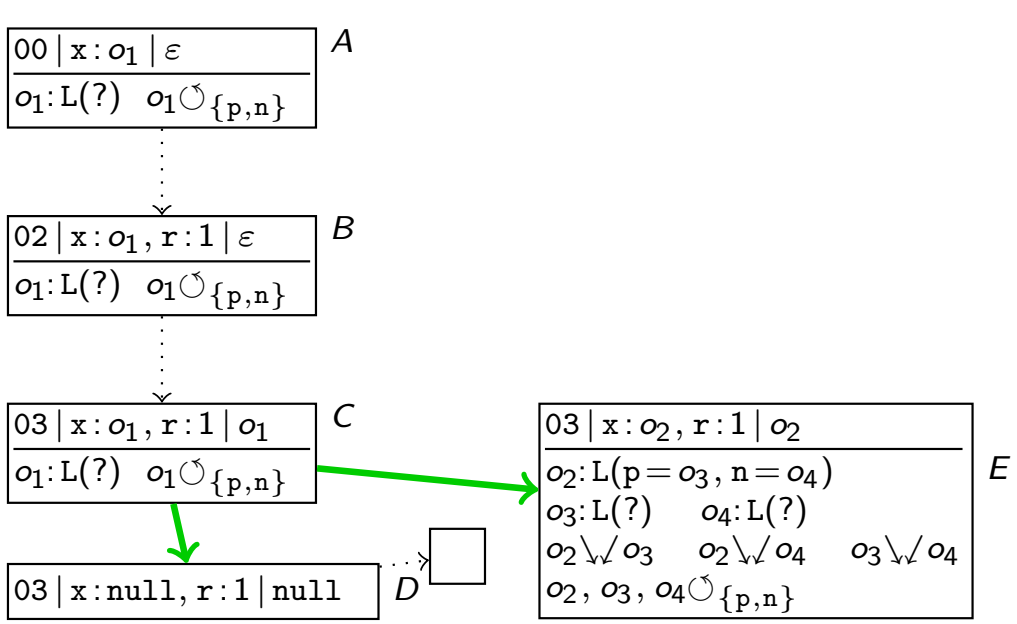

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⇒ Refinement

- In *D*: o_1 is null (↷ program ends)
- In *E*: o_1 replaced by o_2, which exists and has fields:
  - Field values can share (↷ add ↘↙)
  - Field values can be cyclic again (↷ add ↻)

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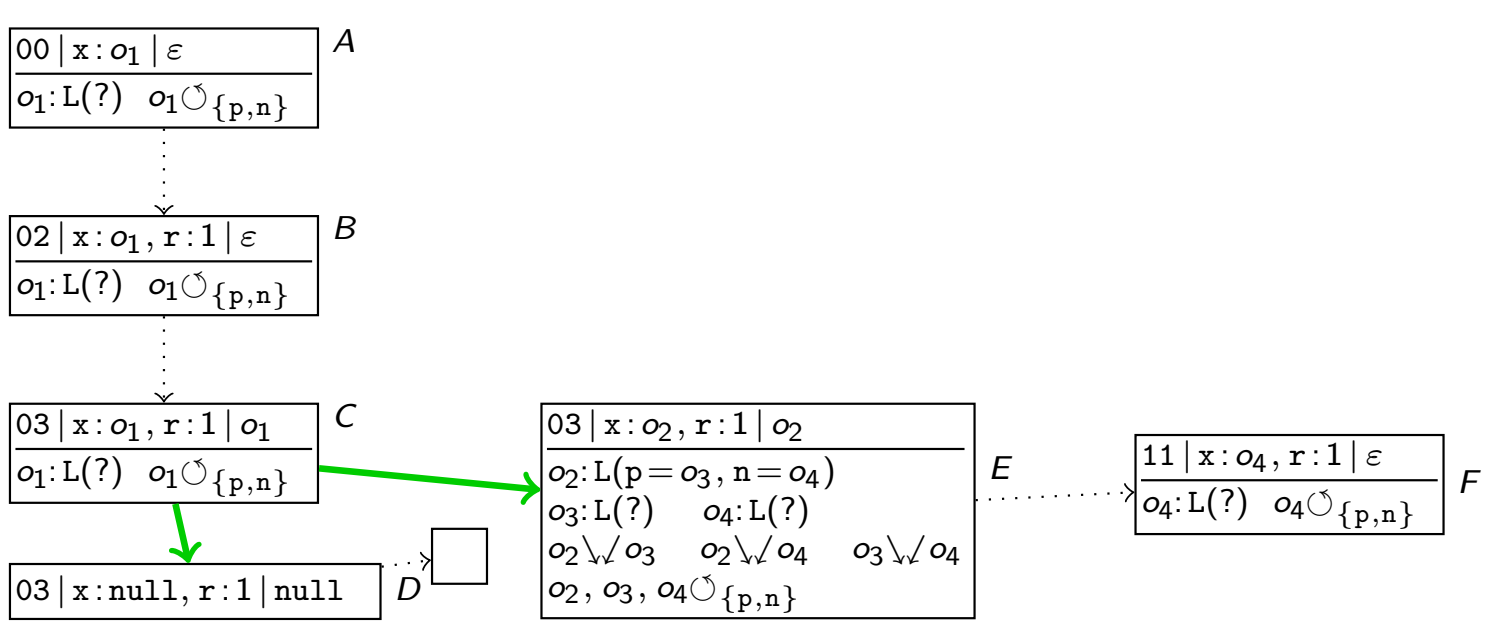

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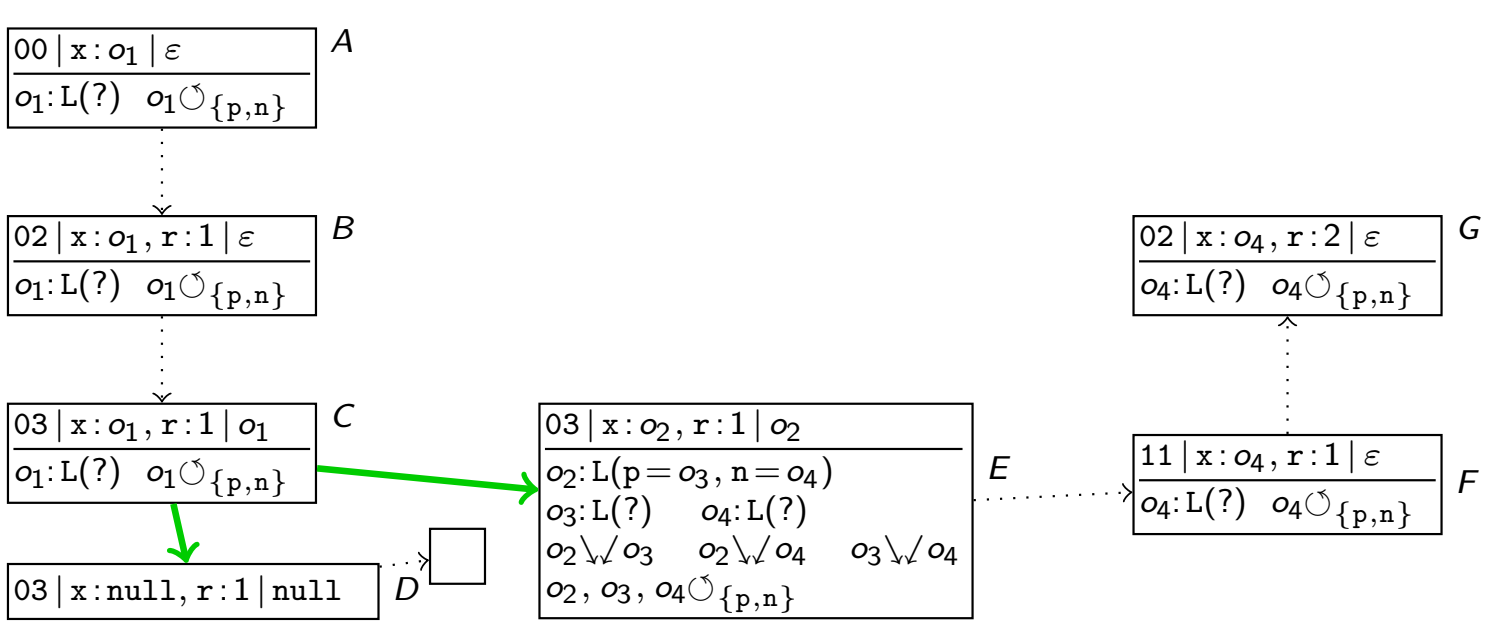

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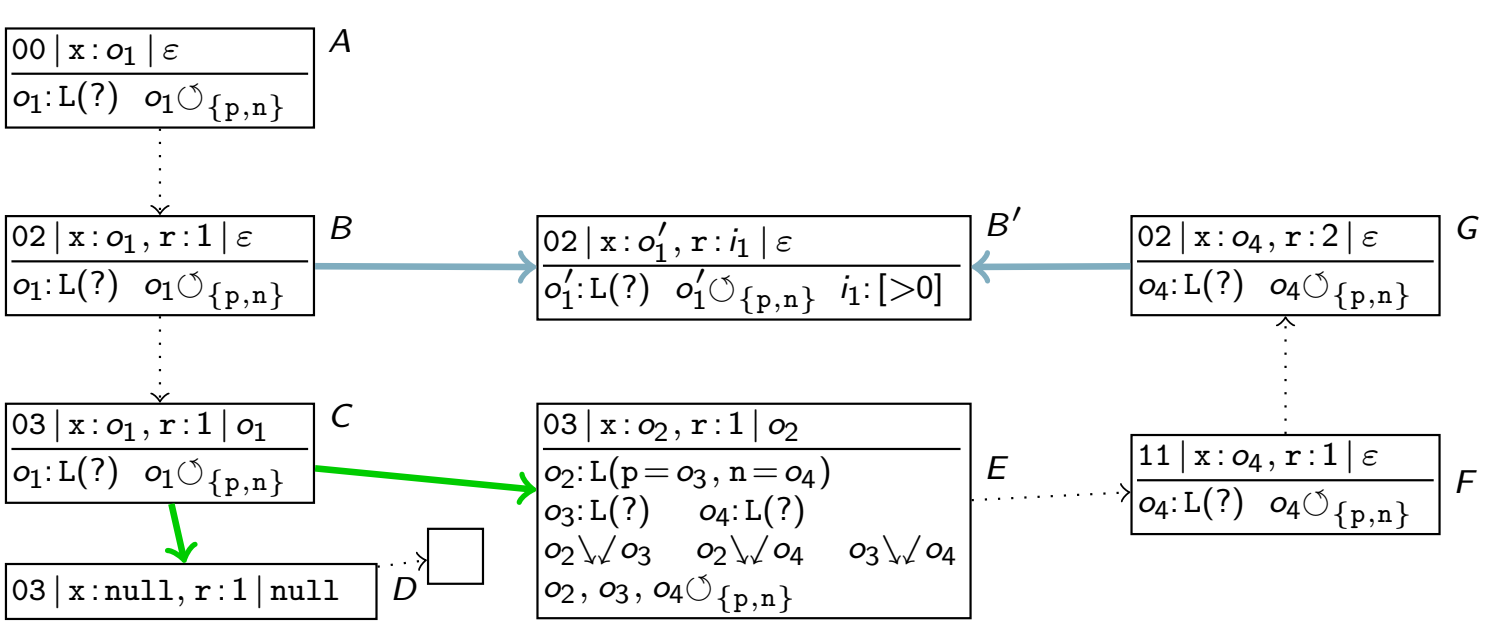

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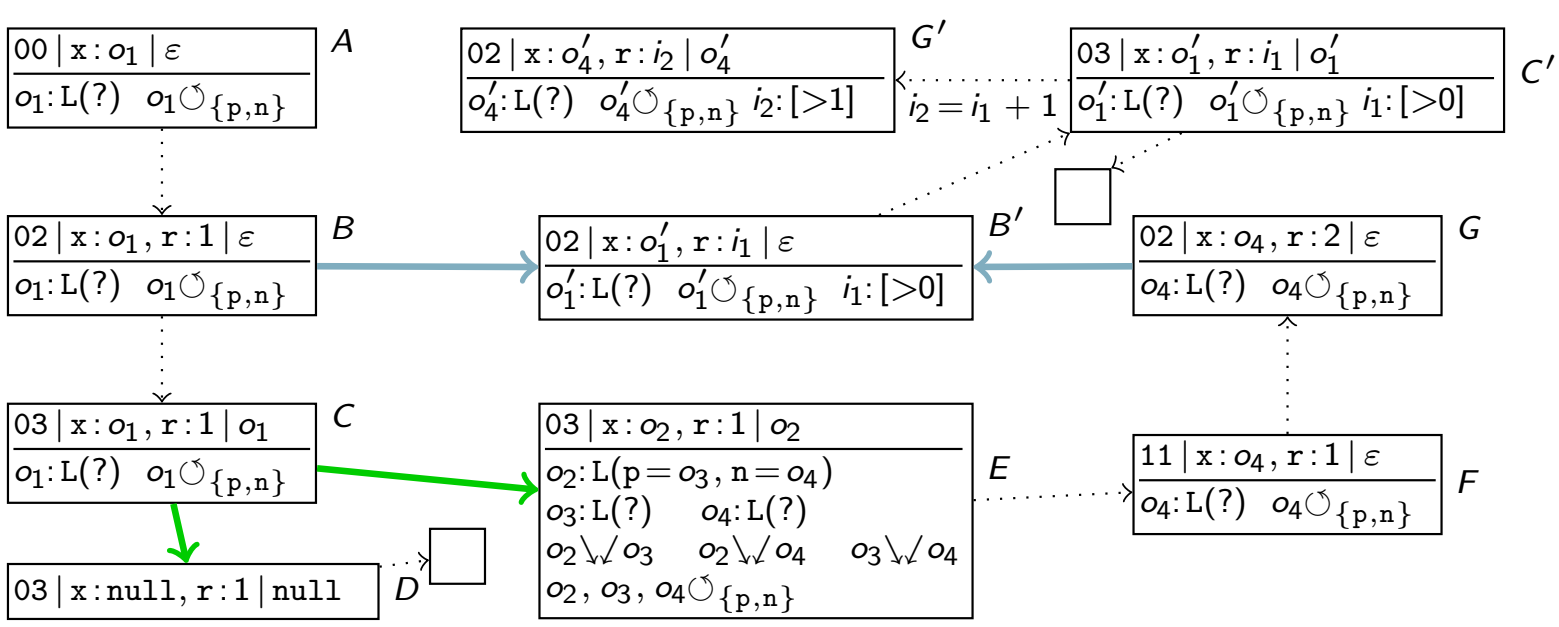

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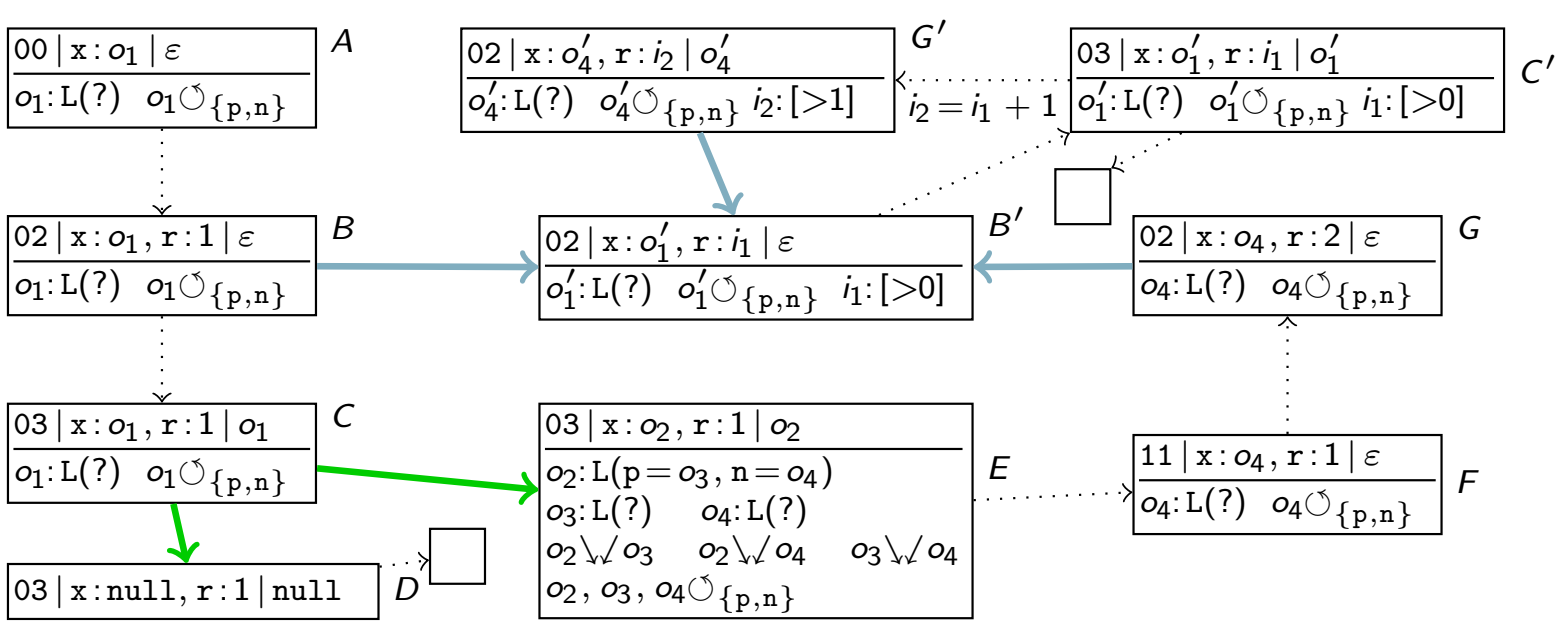

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Transforming values to terms

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$o_3, o_4 \quad 1$

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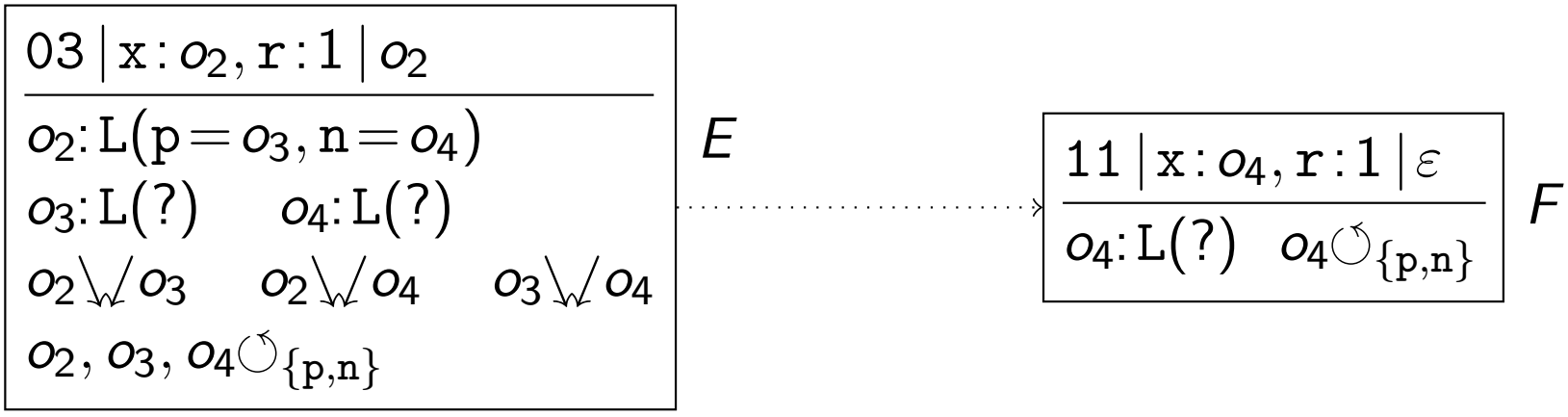

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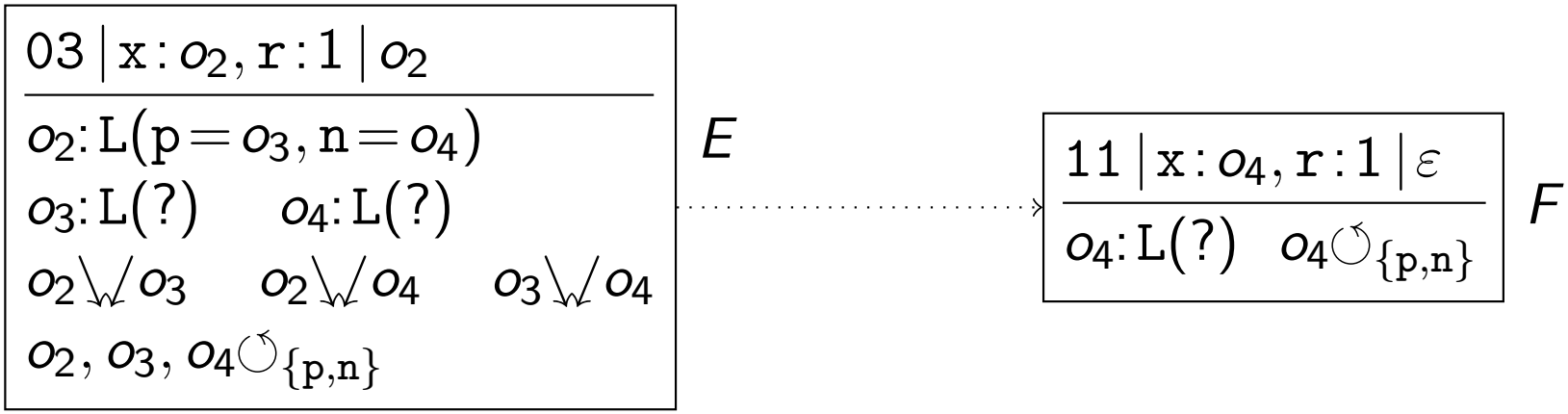

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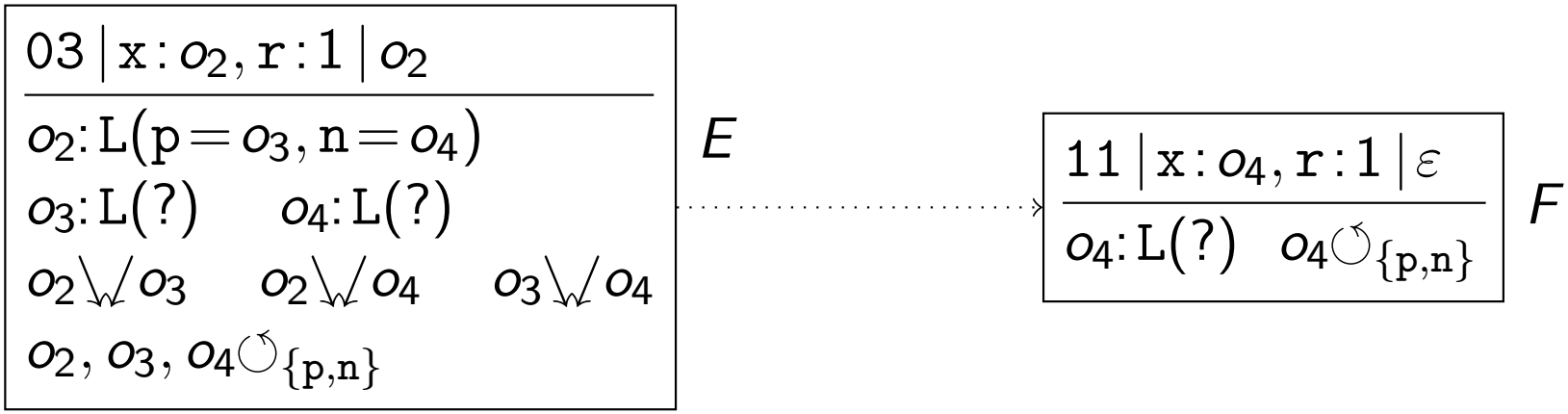

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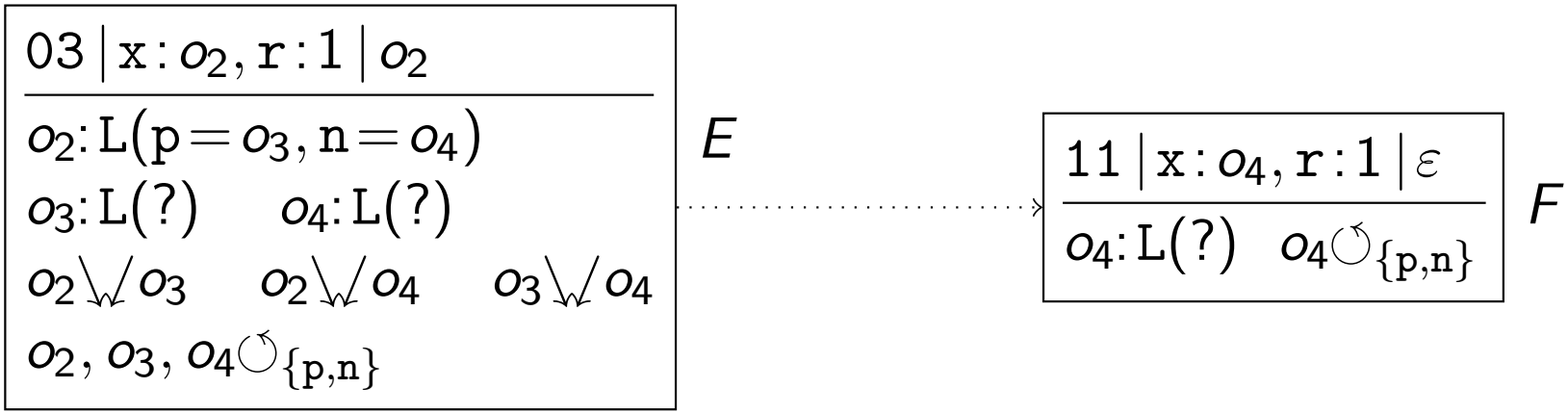

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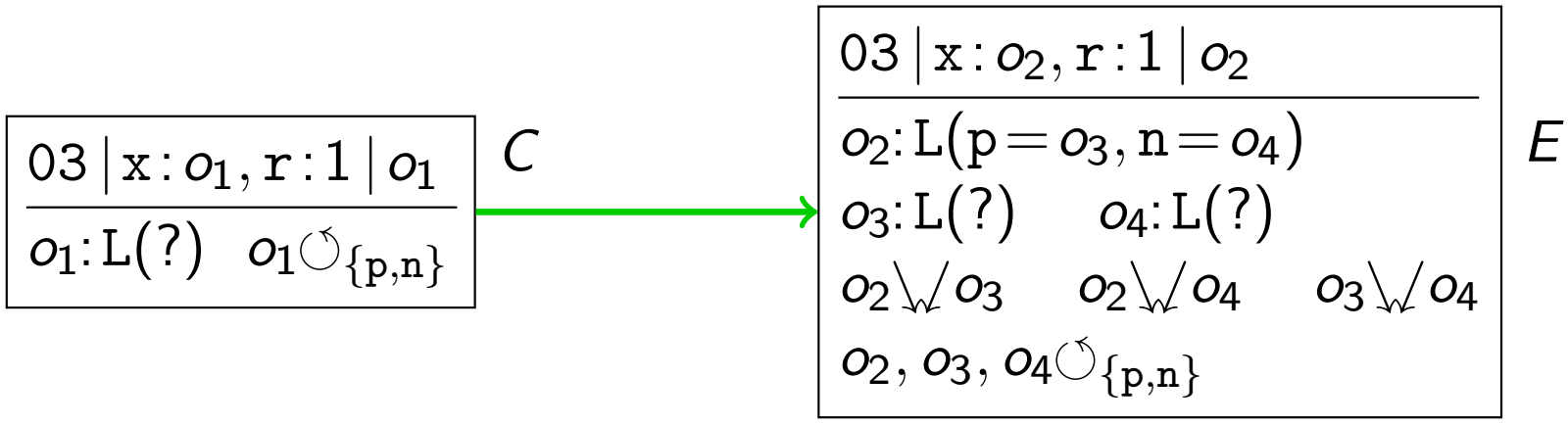

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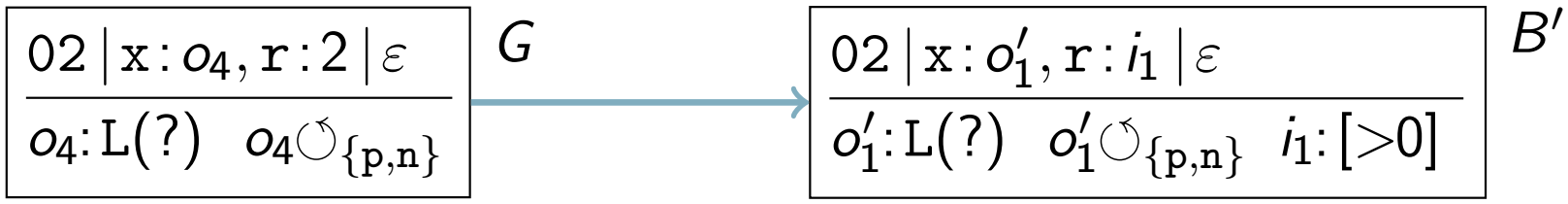

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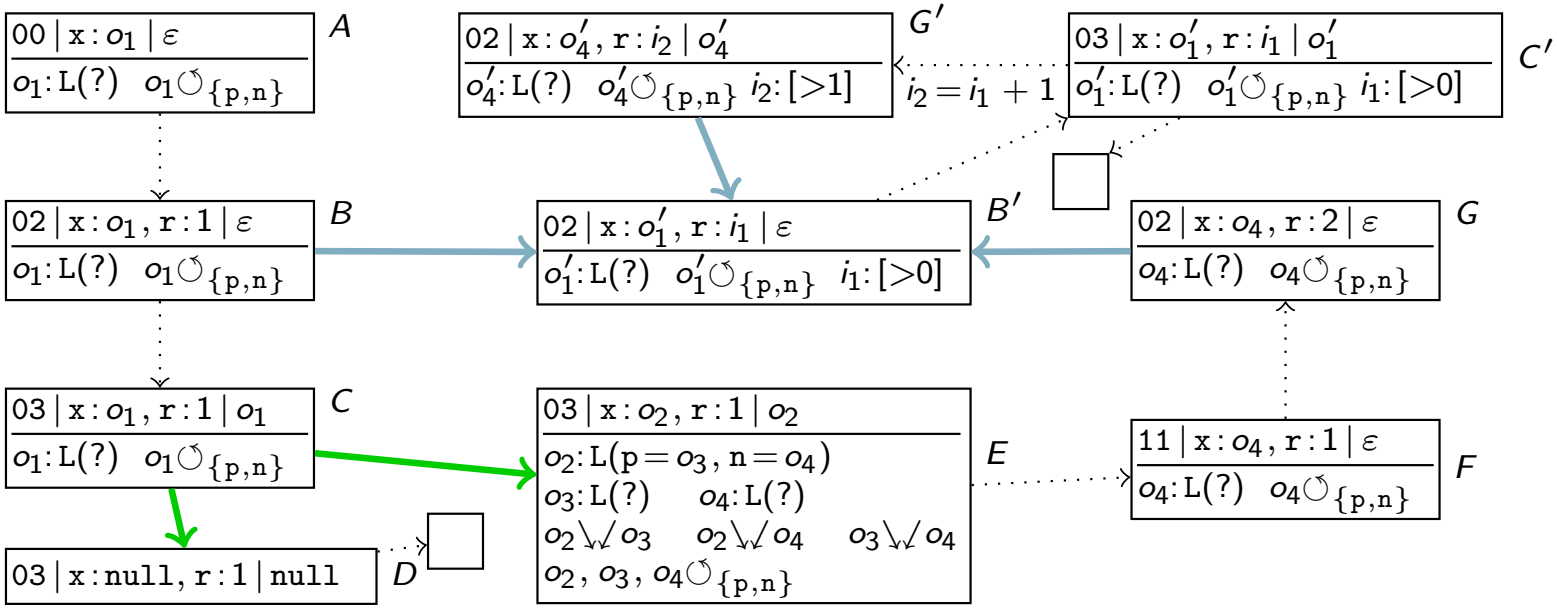

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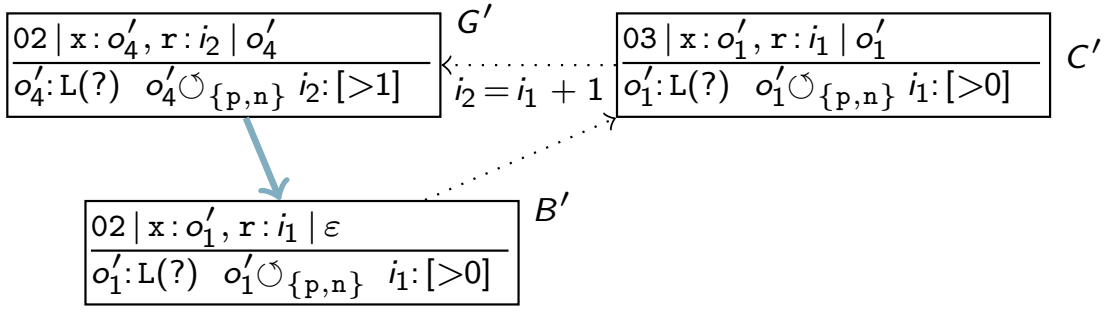

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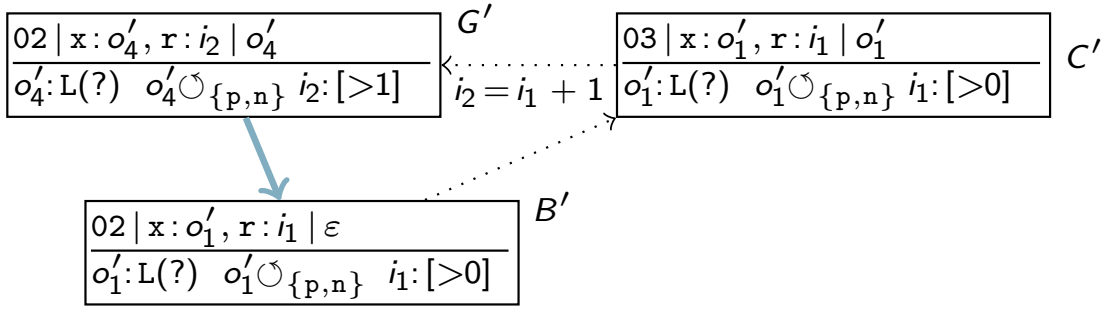

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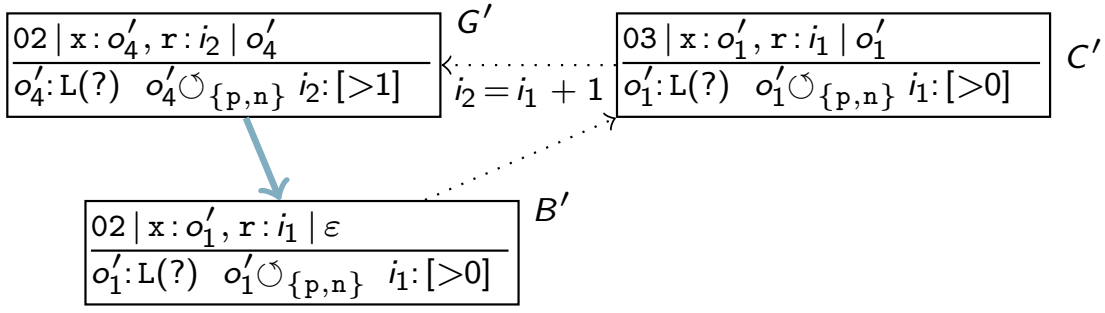

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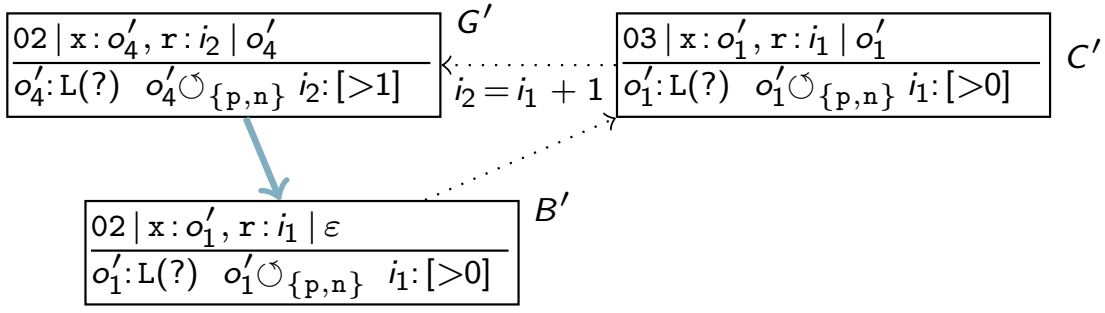

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- Evaluated on collection of 387 programs (including the *Termination Problem Data Base*):

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